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Encyclopedia of Science and Technology

Edited by:
Ramesh Chandra

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ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY

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Ramesh Chandra

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Prof. Ramesh Chandra is an outstanding scientist, revered teacher and an exceptionally successful administrator. He is currently heading Department of Chemistry, University of Delhi, where he is serving as Professor for the last more than 26 years and Founder Director of Dr. B. R. Ambedkar Center for Biomedical Research, University of Delhi, since March 1991. He has been Vice-Chancellor, Bundelkhand University, Jhansi for six years (1999-2005); Member, Planning Commission, Government of U.P, India as well as the President of the Indian Chemical Society (2004-2006). Professor Chandra started his research career at the University of Delhi, thereafter he went to The New York Hospital-Cornell University Medical Center and the Rockefeller University, New York; State University of New York at Stonybrook, USA as Assistant Research Professor. He conducted advanced research at the Harvard University Medical School-Massachusetts General Hospital, jointly at MIT, Cambridge, USA. Over the last 38 years, Professor Chandra has contributed largely in the field of Chemical Sciences and particularly in New Drug Discovery and Development as well as Drug Metabolism. He has to his credit several patents, published more than 300 original Scientific Research Papers/ Review Articles in International journals of repute and six of his internationally acclaimed scientific Books. Prof. Chandra is the recipient of several professional national/ international recognitions; these includes: Millennium Plaques of Honor (Life Time Achievement Award for Contribution in Science & Technology) by the Indian Science Congress Association (ISCA) for 2017-2018, Award of the Highest Honor of Soka University, Tokyo, Japan (2000); J William Fulbright Scholarship (1993); The Rockefeller Foundation USA-Biotechnology Career Award (1993); and several others.

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ABSTRACT

Science and technology (S&T) is broadly acknowledged as an essential tool for promoting and strengthening a nation's socioeconomic development. This volume discusses significant advances in various fields of science and technology over the years, including a knowledgeable workforce and promoting innovative intellectual ideas. Amidst rapid globalization, fast depleting material resources, increasing institutional competition, and growing demands for intellectual property protection, the importance of strengthening the knowledge base is an important issue for the scientific and technology community to recognize. Given the global economic order, the S&T sector should focus on: strengthening applied research and development (R&D) for technology generation; promoting human resource development, particularly in promoting innovative ideas; promoting research and application of science and technology for natural disaster prediction, prevention and mitigation among other spheres.

PREFACE

Recognizing that in a globally integrated, knowledge-based world, comparative advantage shifts to those who can assimilate and employ amazing developments in science and technology for development, this volume examines science and technology and its role in the modern world by reviewing its various applications.

Science and technology are the keys to the progress and development of every country. Technology plays a fundamental role in the creation of wealth, improved quality of life, and real economic growth and transformation in every society. With this in mind, this volume explores the concept of technology, emphasizing the relationship between science and technology, the key role of science and technology in social development, and the significance of science and technology in national development.

The volume critically classifies and examines the role of science and technology in all areas of life including poverty alleviation, affordable energy, water supply, health, agriculture, environmental management, rural development, education and economic growth. Science, technology and innovation each represent a growing category of activities that are highly interdependent but distinct. Science contributes to technology in a number of ways: (a) research tools, laboratory techniques and analytical methods are used in research and ultimately into design or industrial practice through interdisciplinary approaches; (b) research practice as development and assimilation ultimately contributes to useful new human skills and capabilities for technology; (c) The creation of a knowledge base that is increasingly important in assessing the wider social and environmental impacts of technology;(d) new knowledge as a direct foundation of ideas for new technological prospects; (e) sources of tools and techniques to improve the efficiency of engineering design and knowledge bases for assessing design feasibility; (f) knowledge bases to enable new technology for applied research.

The negative impact of technology on science is at least as important: (1) by providing a wealth of resources for new scientific problems, thereby helping to justify the allocation of resources needed to address them effectively and in a timely manner, and expanding the scientific agenda; (2) as a source of otherwise inaccessible tools and techniques to more effectively solve new and tougher scientific problems.

Particular examples of each of these dual-way interactions are discussed. Because there are many indirect and direct links between science and technology, the portfolio of studies with potential societal benefits is broader and more diverse than just looking at the direct links between science and technology would suggest.

Since the advent of recorded history, the development of technology has been closely related to the convenience and prosperity of human life, while science has its origins in natural philosophy and is aided by people's curiosity. Of course, while technological progress is supported by various scientific advances, this does not mean that scientific research is done to develop new technologies, but that scientific knowledge is used only because it is available. In fact, it is more common to develop new technologies for scientific research.

Nonetheless, science is no longer the business of the intellectual world, and scientific results now push the boundaries and expand the potential of human activity, both in space and time. According to the volume, science also has a great influence on people's values, changing the nature of society and becoming the engine of social progress from a civilizational point of view.

CHAPTER 1

EMERGING TECHNOLOGIES

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Emerging from obscurity or extinction are technologies whose development, practical uses, or both remain largely unmet. Although some of these technologies are more established, the great majority are quite recent. Emerging technologies are usually considered as having the potential to transform the existing condition of affairs. Emerging technologies are characterized by radical originality (in both their uses and sources), fast expansion, coherence, significant influence, uncertainty, and ambiguity (Zhang et al., 2018). In other words, a definition of emerging technology is "a very new and rapidly developing technology that demonstrates a degree of coherence that persists over time and has the potential to significantly affect the socio-economic domain(s) as seen in the composition of actors, institutions, and interaction patterns, as well as the associated knowledge production processes.

Figure 1.1: Technology concept presented by a researcher.

Source: https://media.istockphoto.com/photos/technology-concept-presented-by-a-researcher-on-a-digital-screen-picture-id509736958?k=20&m=509736958&s=612x612&w=0&h=MqZ233bLJiFqpd3eHDkGbl8qiI22HdIlrlOmhar_TUk=

However, since its biggest influence will not be noticed for some time, the emerging phase is murky and ambiguous. "Information technology, robotics, nanotechnology, biotechnology, and artificial intelligence are among the rising technologies. Emergence of new technical domains may occur from the technological convergence of heterogeneous systems moving toward similar aims. Convergence combines previously separate technologies such as speech (and telephony features), data (and productivity apps), and video to achieve new efficiencies through resource sharing and interaction

(Antal & Grønli, 2003). Converging technologies reflect historically distinct disciplines that are evolving toward greater interconnectedness and common goals. Emerging technologies are technological advancements that indicate the expansion of a field to gain a competitive advantage. However, opinions about the significance, usefulness, and commercial viability of many emerging and converging technologies differ. Proponents of technological transformation typically see emerging and converging technologies as promising for improving the human condition. While Man has remained essentially unchanged throughout human history (genes change very slowly), all significant change is a direct or indirect result of technological innovation (memes change very quickly), as new ideas are always the result of utilizing technology rather than vice versa, dangers of technological progress, some of these technologies may be dangerous and have the potential to wipe out humanity as we know it.

Alternatively, some of these technologies may pose existential threats. Access to beneficial types of technology is a difficult ethical issue. Some intellectuals, are opposed to the continuous development of cutting-edge technology because they believe its benefits will be distributed inequitably, exacerbating the disadvantaged's plight. Some believe that robots and other forms of automation will eventually cause significant unemployment as machines and software match and surpass workers' ability to perform the majority of routine jobs. Many specialized jobs may be threatened as robotics and artificial intelligence improve. Eventually, thanks to technologies like machine learning, computers may be able to perform a variety of knowledge-intensive tasks that previously required extensive schooling (Zeldin et al., 2008). Increased unemployment at all skill levels, stagnant or decreasing wages for the majority of employees, and growing income and wealth concentration are all likely outcomes as capital owners capture a larger share of the economy. Consumer spending and economic growth may suffer as a result of the majority of people having enough discretionary money to buy the economy's goods and services.

1.1 INNOVATIVE TECHNOLOGY EXAMPLES

Artificial intelligence (AI) is a subset of intelligence demonstrated by machines or software, as well as the computer science discipline responsible for the development of intelligent machines and software. The primary AI researchers and introductory publications define the discipline as the study and development of intelligent agents. An intelligent agent is a system that observes its environment and takes actions to increase its chances of success. In 1956, John McCarthy defined it as “the science of developing intelligent machines.” The major goals (or functions) of AI research are reasoning, knowledge, planning, learning, natural language processing (communication), perception, and the ability to move and control things (Wu et al., 2019). General intelligence (or “strong AI”) is still one of the discipline’s long-term goals. Deep learning, statistical techniques, computational intelligence, and classical symbolic AI are all popular methods. AI incorporates a wide range of methodologies, such as search and mathematical optimization variants, logic, probability, and economics tools, among others.

Figure 1.2: Breaking gender norms.

Source: https://media.istockphoto.com/photos/breaking-gender-norms-picture-id1251395455?k=20&m=1251395455&s=612x612&w=0&h=aXtbDKFO7TPzr78Vq-cWpAMBmO3UQjInmITjlyaiWGE=

1.2 THE THREE-DIMENSIONAL PRINTING METHOD

Three-dimensional printing According to Jeremy Rifkin and others, additive manufacturing, also known as 3D printing, is a component of the third industrial revolution. When combined with Internet technology, 3D printing will enable the transfer of digital designs of nearly any material product to someone else for fast manufacturing, allowing for instantaneous online product purchasing. Although this technology is still in its infancy, it is rapidly evolving and sparked a debate about 3D-printed weaponry in 2013. Chronology of genetic engineering the first successful demonstration of gene therapy for adenosine deaminase deficiency took place in late

1990 or early 1991; however, the treatment was somatic, had no effect on the patient's germ line, and was not inheritable. This paved the way for the treatment of more genetic diseases and raised awareness of germ line gene therapy, a type of treatment that affects patients' gametes and future generations. Approximately 2,000 gene therapy clinical studies were licensed or conducted between September 1990 and January 2014. Anti-cancer vaccines. A cancer vaccine is a vaccination that cures or prevents cancer in high-risk patients (Adamovich et al., 2017). Therapeutic cancer vaccines are used to treat cancer that has already spread. There are currently no vaccines available to prevent cancer in general. Even though some people are opposed to eating meat that did not develop naturally, they believe it is less objectionable than conventional meat because it does not involve killing and reduces the likelihood of animal suffering

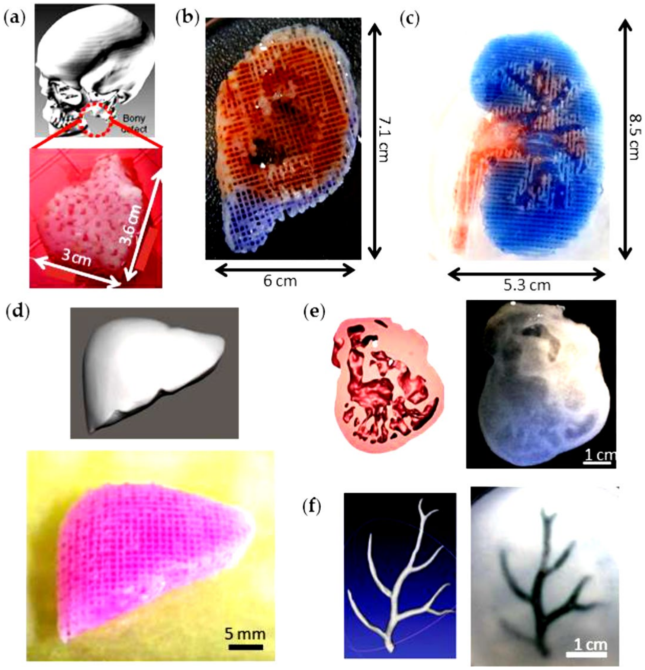

Figure 1.3: 3D printing of biological constructs with heterogeneous and complex structures. Photographs of the 3D-printed (a) a mandible bone construct, (b) an ear cartilage with ear lobule, (c) a kidney with renal pelvis, (d) a liver, (e) a heart cross-section, and (f) an arterial tree. Reproduced with permissions from [18, 19, 21, 22, 24].

Source: Yi H-G, Lee H, Cho D-W. 3D Printing of Organs-On-Chips. Bioengineering. 2017; 4(1):10. https://doi.org/10.3390/bioengineering4010010

1.3 NANOTECHNOLOGY

Nanotechnology (or nanotech) is the manipulation of matter at the atomic, molecular, and supramolecular levels (or nanotech). The term "nanotechnology" was coined to describe a specific technical purpose, now known as "molecular nanotechnology," which involves the manipulation of atoms and molecules to create larger-scale goods. A more comprehensive description of the topic is provided by the National Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension measuring between 1 and 100 nanometers. To reflect the importance of quantum mechanical effects at this quantum-realm scale, this definition has been changed from a specific technological goal to a research category that includes all types of research and technologies about the unique properties of matter that occur below the specified size threshold (Woolgar & Lezaun, 2013).

1.4 ROBOTICS

Robotics is the branch of technology concerned with the development, application, and use of robots, as well as the computer systems required to control, sense, and analyze data about them. These technologies include automated equipment that can replace humans in dangerous situations or manufacturing processes, or that mimic humans in appearance, behavior, and/or intelligence. Sophia, a social humanoid robot created by Hong Kong-based Hanson Robotics and unveiled on April 19, 2015, is a good example of a humanoid robot. As many current robots are influenced by nature, this has aided the study of bio-inspired robotics. Stem cell-based therapy is a treatment method that involves injecting fresh adult stem cells into sick or injured tissue. Many medical experts believe that stem cell treatments have the potential to change the course of human illness and reduce suffering (Wang, 2009). The ability of stem cells to self-renew and produce offspring with varying degrees of differentiation capacity enables the development of tissues capable of replacing sick or damaged body components with minimal risk of rejection and negative consequences. . CAR-modified T cells have evolved and are being used to treat B-cell malignancies, as well as other cancer immunotherapies. Despite the promising results of this cutting-edge technology, CAR-T cells are not immune to the constraints that must be overcome to deliver dependable and more effective therapies for various types of cancer.

Figure 1.4: Automated robot carriers and robotic arm in smart distribution.

Source: https://media.istockphoto.com/photos/automated-robot-carriers-and-robotic-arm-in-smart-distribution-picture-id1341262391?k=20&m=1341262391&s=612x612&w=0&h=OhC5v7E8ghqW4zP1iPuCMcjYVLhCSatqKw-7Wj8jYvgs=

1.5 DLT

The technology that underpins distributed ledgers. Blockchain and distributed ledger technologies both provide immutable and transparent transaction records. A wide range of applications, from supply chains to cryptocurrency, has been proposed in which an open, decentralized database is required. When certain conditions are met, smart contracts or self-executing transactions occur. The goal is to reduce transaction costs and delays while providing greater security than standard contract law permits. The initial concept was developed, but it was not realized until the advent of blockchain technology, the development of ground-breaking technology. Many resources are dedicated to the development of technologies because innovations produce significant economic benefits and innovation promotes economic development (money and effort). Research and development attempts to advance technology in general, research and development includes the development of new technologies (Wynne, 2007). Applied research is a type of systematic investigation in which science is applied to real-world situations. It collects and applies a subset of the research communities' ideas, information, methodologies, and techniques for a specific, usually government-, business-, or client-driven goal. Science policy is the branch of public policy concerned with policies that influence how the scientific and research enterprise is carried out, including science funding, and is frequently used to support other national policy goals such as commercial product development, weapon development, health care, and environmental monitoring.

1.6 PATENTS

The top 30 AI patent applicants in 2016 Patents grant inventors the exclusive right to produce, sell, use, lease, and benefit from their innovative technology ideas for a set period (typically 20 years, but this varies depending on the jurisdiction). The underlying technology for blockchain systems, robotic advancements, innovative materials, and artificial intelligence may be patentable. The Internet of Things will have the largest market size, while AI will be the most prolific upcoming technology in terms of patent applications and grants. In terms of market size, big data technologies, robots, artificial intelligence, 3D printing, and the fifth generation of mobile services (5G) came next. Since the early days of artificial intelligence (AI) in the 1950s, inventors have filed 340,000 patent applications related to AI, and researchers have published 1.6 million scholarly publications, the vast majority of which were published in 2013(Alexander et al., 2006).

1.7 DARPA

The Defense Advanced Research Projects Agency (DARPA) is in charge of developing cutting-edge military technology for the Department of Defense in the United States. President Dwight D. Eisenhower established DARPA in 1958 as the Advanced Research Projects Agency (ARPA). Its goal was to establish and implement research and development programs that would advance science and technology beyond the needs of the military. DARPA-funded technologies, such as the Internet and GPS technology, have had a significant impact on a wide range of non-military professions.

- Prizes And Contests In Technology

There are incentives available to encourage technological innovation (typically linked with new technologies) . Notably, although some of these rewards recognize achievement after the fact by analyzing the merits of technological advancements, others serve as an incentive by conducting competitions for incentives provided for unrealized goals. Turing Award is given each year by the Association for Computing Machinery (ACM) to “a person acknowledged for technical contributions to the computing community.” Computer contributions must be large and long-lasting. The Turing Award, which was increased to $1 million in 2014, is widely regarded as the highest honor in computer science (Woellert et al., 2011). Technology Academy Finland, an independent institution founded in collaboration with the Finnish government and business sector, awards the Millennium Technology Prize every two years. The first laureate was Tim Berners-Lee, the creator of the World Wide Web. In 2003, David Gobel established the Methuselah Mouse Prize (Prize) to encourage the development of novel life-extension therapies for mice, which share genetic similarities with humans. Dr. Andrzej Bartke of Southern Illinois University was awarded the Mouse Prize for breaking longevity records, Dr. Stephen Spindler of the University of California was awarded the Mouse Prize for late-onset rejuvenation techniques, and Dr. Z. Dave Sharp was awarded the Mouse Prize for his work with the medication rapamycin. Science fiction has frequently encouraged innovation and new technologies. Many rocketry pioneers, for example, were inspired by science fiction in the media, this is referred to as “cutting edge.” The phrase “bleeding edge” has been applied to numerous developing technologies as an allusion to the words “leading edge” and “cutting edge.” Because of the insecurity of the software or hardware, it tends to signal further development, but at a higher risk (Whitcombe et al., 2014). The term was originally mentioned in early 1983 by an unidentified financial executive about Storage Technology Corporation.

1.8 ROBOTIC PROCESS AUTOMATION (RPA)

Software robots that mimic human-computer and software interaction can be built, deployed, and maintained more efficiently using RPA software. Understanding what is displayed on the screen, performing essential keystrokes, and traversing systems are just a few of the tasks that software robots may perform. Unlike humans, software robots do not need to stretch or take coffee breaks to accomplish work.

1.8.1 What Are The Benefits Of RPA For Businesses?

Firms can increase their efficiency, flexibility, and responsiveness by automating robotic procedures. When tedious duties are removed from employees’ workdays, their enjoyment, commitment, and productivity all improve.

RPA is a simple and non-intrusive technology that can accelerate the process of digital transformation. It is also suitable for automating activities on systems that lack VDI, database access, or application programming interfaces (APIs).

In robotic process automation, software robots running on a real or virtual system act as the "robot."RPA, according to Nintex's director of product Aaron Bultman, is a type of business process automation that allows anyone to generate instructions for a robot or "bot" to perform. Because RPA bots can simulate the majority of computer-human interactions, they can perform a wide range of excellent activities quickly and in large numbers (Verbeek et al., 2002). This form of automated technology is supposed to appear dull, especially in comparison to cinematic robots. RPA can automate the most time-consuming and repetitive computer-based processes and procedures. The files can be copied and pasted or relocated to a different location.

Figure 1.5: Manager industrial engineer using tablet check and control automation.

Source: https://media.istockphoto.com/photos/manager-industrial-engineer-using-tablet-check-and-control-automation-picture-id973143870?k=20&m=973143870&s=612x612&w=0&h=bR2IfFVo3OjKnOZC0wtlrYGbMVb_It-wB64UXGCdxdrc=

Robotic Process Automation (RPA) automates time-consuming and repetitive operations that were previously performed by humans. RPA claims to boost organizational efficiency in this manner.

Let's postpone the RPA review of your internal processes and workflows for the time being. We'll go through a few key standards to help you and your team better understand what RPA is and how it may help you. These criteria can be useful when discussing RPA with non-technical colleagues. In one of the most significant areas, repetitive data work is necessary (Terrones, 2003). RPA is an excellent alternative for tasks that require a high level of human data processing. "Logic-based solutions are being considered for repeated tasks or data-intensive procedures that require RPA systems."

Landreman recommends using the four basic checkboxes given below to find probable RPA matches.

- All applicable rules and guidelines must be followed during the procedure.

For the treatment to be effective, repetition or a specific trigger are both required.

The process's inputs and outputs must be stated in detail.

- The task should be given adequate attention.

What are some examples of robotic process automation (RPA) applications? Business procedures and applications examples

RPA has the potential to reduce the amount of time that non-IT professionals spend on routine tasks.

RPA should be far easier to explain and promote outside of the IT field than serverless or micro services. This is already addressed in the definitions that came before it. RPA implementations may also improve the lives of non-IT personnel by removing time-consuming office tasks (Sismondo, 2018). A field service technician, for example, may have a more difficult time appreciating the benefits of containerization.

"RPA is embraced by businesses and organizations because it helps them enhance productivity across a wide range of demographics," says Muddu Sudhakar, CEO of Aisera (including users, customers, employees, sales and marketing personnel, business people, accountants, legal and finance experts, etc.).

When provided specific instances of how technology might be used in the company, the light bulbs frequently turn on faster. Let us return to data-intensive approaches as a starting point. Data can be collected and handled in a variety of ways by a person or organization.

Take into account the financial, customer service, and human resources procedures.

Consider how much work goes into something like finance: Processing receivables and payables have traditionally required a large amount of manual, repetitive effort from specialist people. The rationale for such ambitious RPA claims in specific business functions is that it is expected that by 2020, 73 percent of corporate controllers would have deployed RPA in their finance departments, up from 19 percent in 2018 (Shannon et al., 2010). Human resources and customer service are two of the most typical corporate divisions where repeated, rule-based procedures requiring a large amount of data are performed. Insurance and financial services are two industries that suit the bill. Eggplant COO Edwards provides the following usage case to demonstrate his point. Returns to the processing of considering swapping an internet purchase for yourself and the retailer from whom you most recently purchased it. These "free" returns, on the other hand, are a ruse.

Previously, refunds were performed manually and at a high expense. According to Edwards, RPA helps businesses to control returns without incurring additional costs or hindering operations. RPA software now handles a range of repetitive operations to handle returns, such as sending a message to confirm receipt, updating inventory, changing a customer's payment method, and ensuring the internal billing system is up to date, to name a few of the most time-consuming ones (Suryanarayana et al., 2001).

When it comes to returning a pair of shoes that don't fit properly, both customers and businesses would profit significantly from Landreman's suggested return policy. This rule-based process, which has specified inputs (such as starting the return and returning the item) and outputs, will surely assist retail businesses in particular (such as issuing you a reimbursement).

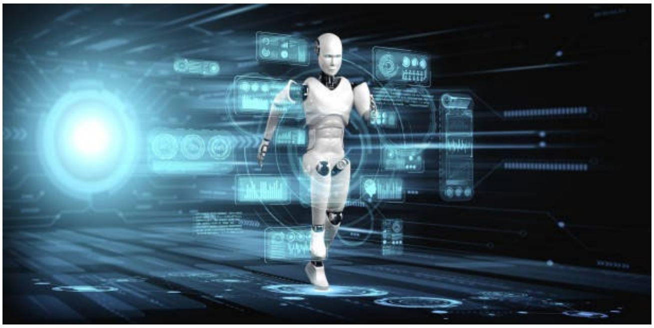

Figure 1.6: Running robot humanoid showing fast movement and vital energy.

Source: https://media.istockphoto.com/photos/running-robot-humanoid-showing-fast-movement-and-vital-energy-picture-id1304260161?k=20&m=1304260161&s=612x612&w=0&h=HzK8on59iQ3w_qfD7C_IlUjY3EwwhOI2b_fpHOjLlWo=

During this essential procedure, there are several “opportunities” for inefficiency, blunders, and other challenges. Furthermore, it is exhausting. RPA was created to make tasks like these easier (Swierstra & Rip, 2007).

Employees can focus on more critical tasks when routine tasks like data input are automated via RPA, according to Kofax’s Huff.

1.8.2 The Several Advantages of RPA

What further benefits may RPA give, outside of the HR, financial, and customer service benefits already discussed? The DevOps Institute’s principal research analyst, Eveline Oehrlich, recommends businesses consider what they could do with the time saved by IT.

According to Ehrlich, “the RPA productivity potential is unavoidable.”

Even while robots will continue to develop, they will not replace all of our employment.

“It is intended that by utilizing these bots, CIOs would be able to free up their personnel to work on more vital projects that support their company’s digital transformation goals. Remember that many RPA suppliers offer free trials so that prospective consumers can test the waters before committing to a long-term contract.” (Small, & Klavans, 2014).

1.8.3 How Robotic Process Automation (RPA) Is Related To Artificial Intelligence (AI)

In 2022, keep an eye out for these four RPA (Robotic Process Automation) developments.

Six open-source programs can help with robotic process automation (RPA)

Credentialing and education programs for robotic process automation (RPA)

Even as more businesses adopt RPA, the relationship between RPA and AI remains contentious. According to a study paper published by Harvard Business Review Analytics, some believe that RPA does not qualify as artificial intelligence (Rogers & Marres, 2000).

1.8.4 What Distinguishes RPA And AI From One Another? What Are The Distinctions Between Robot Process Automation And Artificial Intelligence?

In reality, why is there so much disagreement in the first place? RPA does not learn as it goes, whereas deep neural networks do. As we previously discovered, when a web form field changes, the RPA bot is frequently unable to figure it out on its own.

RPA and AI are becoming increasingly interwoven in any way.

"RPA systems that repeat rule-based human actions complement AI technologies that augment and mimic human judgment and behavior," writes Huff at Kofax. To increase production, both traditional "white-collar" knowledge workers and "blue-collar" service workers collaborate as a complementary engine.

Figure 1.7: Smart industry robot arms for digital factory production.

Source: https://media.istockphoto.com/photos/smart-industry-robot-arms-for-digital-factory-production-technology-picture-id1279641279?k=20&m=1279641279&s=612x612&w=0&h=MV_54-lBq1Qg3KQMF01JHGJXG7szCQn-QSBvMGT9be20=

RPA's capabilities improve as it is integrated with AI technology, according to Dave Costenaro, head of Jane.ai's AI research and development.

Deep neural networks (DNNs), a major AI technology, are "adding additional firepower to the RPA armory, particularly in vision and language tasks," according to Costenaro. RPA workflows could not previously be enabled at decision nodes, but these new functionalities can (Rao & Cheetham, 2001). This information can then be used by algorithms to make better-educated judgments about how information is routed and processed in the future. According to Oerlich, as data complexity increases, human-level decision-making is becoming more and more similar to human-level AI use and development. As a result, choices are made faster and without the risk of human bias.

1.9 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Artificial intelligence (AI) is used in a variety of applications, including game consoles and the interpretation of complex data at work. Engineers and computer scientists are working hard to create robots that can recognize and respond appropriately in an emergency. AI in its early stages of use in business is becoming increasingly widespread. Internet giants like Google and Facebook have already incorporated artificial intelligence and machine learning into their businesses after extensively investing in these technologies. However, this is only the beginning; AI will be integrated into a broader range of products in the coming years (Porada et al., 2013).

Figure 1.8: Business investment and AI data analysis.

Source: https://media.istockphoto.com/photos/business-investment-and-ai-artificial-intelligence-data-analysis-picture-id1332827275?k=20&m=1332827275&s=612x612&w=0&h=GEtVWz5FBGdhgB03ZzawpSVznUXMlKJ-8go97Ej5TNLY=

1.9.1 Is Artificial Intelligence Real?

According to John McCarthy, a Stanford researcher, AI is the science and technology of making intelligent robots, specifically intelligent computer programs. One component of artificial intelligence is the use of computers to read human minds, while AI is not limited to biological processes.

Artificial intelligence (AI) is the development of computer systems and software that can simulate human mental processes.

In AI research, knowledge engineering strategies must be used. Machines and programs must have access to a wide range of knowledge about the world to consistently mimic human behavior. Qualities, categories, objects, and their interactions are all required for AI to do knowledge engineering (Banerjee & Williams, 2013). Teaching robots common sense, problem-solving skills, and analytical reasoning is tough and time-consuming.

AI services are classified as horizontal or vertical.

Vertical AI can be thoroughly discussed.

These services are focused on a single task, such as scheduling a meeting or automating repetitive tasks. Vertical AI bots might be mistaken for humans because they are so adept at a certain task.

1.9.2 What is Horizontal AI, Exactly?

Because of the way they’re designed, these services can do a variety of things. There isn’t a single obligation that must be met. Microsoft created Cortana, Siri, and Alexa to emphasize the horizontal nature of artificial intelligence. When used in question-and-answer settings like “What is the temperature in New York?” or “Call Alex,” these services become more widely available. They can be used for a variety of purposes, not just one.

Figure 1.9: Low poly brain or artificial intelligence concept.

Source: https://media.istockphoto.com/vectors/low-poly-brain-or-artificial-intelligence-concept-symbol-of-wisdom-vector-id1331059443?k=20&m=1331059443&s=612x612&w=0&h=Cf5lOQcgwRXQ_1B1wvoD7Aw1Lal8W-G2ANE7cKGZsEOs=

Artificial intelligence (AI) is generated by studying how the human brain solves issues and then applying analytical approaches to build complex algorithms that can perform similar jobs. AI is a system that can make judgments without the assistance of a human. These systems require algorithms that can learn from their mistakes. In this scenario, machine learning is applied (Pahlavan & Makela, 2002).

1.10 BLOCKCHAIN

A "blockchain," as the name implies, is a decentralized, openly shareable ledger of digital transactions. Because of the way blockchain works, only a tiny number of people can access the data stored on it. Using blockchain cloud services, transactional data may be readily retrieved, integrated, and distributed. Cryptographic hashes are used to link fragmented data blocks together.

Figure 1.10: Rendering of blockchain.

Source: https://media.istockphoto.com/photos/3d-rendering-of-blockchain-on-technology-background-picture-id1321058115?k=20&m=1321058115&s=612x612&w=0&h=QnEfARWmFAu8adRioPBsQsG31VkUc_feHmaHN8kEbnE=

By offering a single source of truth, blockchain reduces data duplication and increases security. Because data can only be updated with the approval of the majority of stakeholders, blockchain systems prevent fraud and data tampering. Blockchain-based ledgers enable sharing but not modification. If someone tries to change the data, all participants will be notified, and they will know who is to blame.

1.10.1 What's the Big Deal About Blockchain?

In other words, consider a blockchain to be a distributed ledger. A peer-to-peer network connects each block in a chain to the one before it. Each transaction is assigned a unique identification, or a digital fingerprint, using cryptographic trust and assurance technology. The chain is founded on trust, accountability, openness, and safety (Otsuka & Kakeshita, 2002). This promotes third-party confidence by allowing organizations and commercial partners of various sizes to access and share data.

Each member in a decentralized, highly scalable, and provable recording system preserves an encrypted record of each transaction. With blockchain technology, intermediaries and other fees can be removed. Decentralization of the single source of truth lowers the cost of carrying out dependable economic transactions between parties who may not completely trust one another. Every member of a permissioned blockchain system keeps an encrypted record of all transactions and has network access.

Every company or group of companies can use this cutting-edge technology to retain a safe, up-to-date, and easily shareable record of their transactions. There is no single point of failure because the data is distributed across multiple servers.

The definitions of blockchain, its underlying technology, and instances of how it has been implemented in practice are provided here.

- Lack of concentrated confidence

To secure data integrity without relying on a centralized authority, businesses use blockchain technology instead of other data repositories. You can have decentralized trust as long as you have good evidence(Nisbet et al., 2002).

- The "blocks" of a blockchain

When data is stored in blocks that are linked to one another, a chain-like structure is generated, hence the name "blockchain." The only way to add new blocks to a blockchain is through blockchain technology. Once a block has been added to the blockchain, it cannot be modified or withdrawn.

The algorithms for establishing a consensus are as follows:

Algorithms that enforce rules within a blockchain. Participants in the blockchain can feel assured that their rules will be upheld through a consensus approach.

Nodes in a distributed ledger are as follows:

Blocks of blockchain data are stored at nodes, which are storage devices that maintain data synchronized or current. Any node may simply determine if a block has been altered since it was introduced. When a new full node joins the blockchain network, a copy of all previous blocks is downloaded(Moore, 2013). Nodes that have synchronized with the rest of the network and have access to the most recent blockchain can begin receiving new blocks.

Figure 1.11: Businessman holding a bitcoin as part of a business.

Source: https://media.istockphoto.com/photos/businessman-is-holding-a-bitcoin-as-part-of-a-business-network-picture-id1313455188?k=20&m=1313455188&s=612x612&w=0&h=lBZ6AYg26dQhIkc842rN3pDB_t1R6VkoQUt-WBAxDobY=

There are two kinds of nodes on the blockchain:

Each complete node has a copy of the blockchain that is identical to the other nodes.

Light-weight nodes can be asked for earlier blocks, but they only keep the most recent ones.

There are three distinct types of blockchains.

- A blockchain that is open to the entire population.

Everyone is welcome to join a public (or permissionless) blockchain network. The bulk of cryptocurrencies that run on a public blockchain is controlled by consensus algorithms or rules(MacIá, 2005).

- Blockchain with permissions or a personal blockchain.

Organizations can control who has access to their blockchain data and how it is used by using a private blockchain, also known as a permissioned blockchain. Those who have been given permission can view certain data sets.

A blockchain that is federated or consortia

A blockchain network in which the consensus process is strictly governed by a set number of nodes or stakeholders (mining process).

1.10.2 Blockchain's Economic Value

The use of blockchain technology is expected to grow in the next years. This new technology is both imaginative and disruptive because it will transform existing organizational procedures by improving their reliability and security.

Businesses benefit from blockchain technology in the following ways:

- Increases business partners' trust by providing accurate and consistent data.

Data silos are avoided by combining data from multiple sources into a single system via a distributed ledger accessible only to those allowed access(Martin, 2010).

The security of sensitive information is of the utmost importance.

Third-party mediators are no longer required.

It is conceivable to provide all participants with tamper-proof, real-time recordings.

This approach allows participants to vouch for the authenticity of commodities entering the trade.

This technology allows products and services to be tracked throughout the supply chain.

Collaborations between blockchain and the Internet of Things: Blockchain is no longer considered cutting-edge technology. Using other technologies such as artificial intelligence (AI), the Internet of Things (IoT), and machine learning to improve blockchain solutions and achieve corporate objectives has been a huge benefit for blockchain. Because of these big technology links, consumers can receive valuable insights from their data(Badgujar et al., 2008).

Traditional IT systems cannot handle the massive amounts of data created by an IoT implementation. Because of the volume, speed, and variety of data generated by IoT networks, they have the potential to overwhelm business systems or greatly limit the capacity to make timely decisions based on trustworthy data. With blockchain's distributed ledger technology, scalability challenges can be addressed while boosting security and transparency.

Figure 1.12: Businessman holding blockchain network and cloud computing online.

Source: https://media.istockphoto.com/photos/businessman-holding-blockchain-network-and-cloud-computing-online-picture-id1312894674?k=20&m=1312894674&s=612x612&w=0&h=WyomA-DSPF7AvakGz5tW0bLUCTN-cYbCQfF5y4jlSSiQ=

1.10.3 What is Hyperledger, Exactly?

Hyperledger is a Linux Foundation-supported open source initiative that intends to facilitate global blockchain collaboration. The fundamental purpose of Hyperledger is to produce open-source blockchain implementations that fulfill the needs of enterprises in terms of scale, performance, and security (Liu & Zhang, 2011). Hyperledger maintains its impartiality and accessibility as a community of people who contributed code to the development of Hyperledger Fabric, the software used as the foundation for blockchain efforts by a variety of organizations.

1.11 INTERNET OF THINGS (IOT)

The Internet of Things (IoT) is a network of interconnected "things" that communicate and exchange data with other devices and systems via the internet (IoT). These gadgets come in different shapes and sizes, from simple household appliances to enormous industrial machinery. It was estimated that by 2020, there will be 10 billion connected devices and that by 2025, there will be 22 billion connected gadgets (IoT).

Figure 1.13: Digital transformation concept system engineering binary code picture.

Source: https://media.istockphoto.com/photos/digital-transformation-concept-system-engineering-binary-code-picture-id1321462048?k=20&m=1321462048&s=612x612&w=0&h=lX-pTNbf8XkFJR6lObJFN9J953QP2QfrK-IbE-eQeAt4=

1.11.1 What is the Internet of Things (IoT) Significance?

The IoT has recently emerged as a critical breakthrough for the twenty-first century. Things like home appliances and automobiles can now be linked to the internet via embedded devices, allowing people and processes to always communicate with one another (Lieber, 2003).

Mobile devices and low-cost computers may now communicate and collect data without the presence of a human operator. In today's hyper-connected world, digital technology can record, monitor, and influence every interaction between linked entities. The physical and digital worlds collide, but they complement one other.

1.11.2 What Technological Advancements Have Enabled the Internet of Things?

Although the concept has been around for a long, the Internet of Things has only just come to fruition.

Sensor technology that is both affordable and energy efficient is becoming more widely available. Because of the widespread availability of low-cost and dependable sensors, an increasing number of manufacturers can now benefit from IoT technology.

It's critical to be available. Sensors and other "things" can now be easily linked to the cloud using a variety of internet network protocols, allowing for rapid data transfer.

- Cloud computing infrastructure Because of the introduction of cloud platforms, businesses and consumers may now receive the infrastructure they need to expand without having to worry about maintaining it (Bøe et al., 2011).
- Data analysis applications based on machine learning. As machine learning and analytics advance, businesses may be able to acquire insights more quickly and easily, as well as access to diverse and massive amounts of cloud-stored data. Data from IoT stimulates the development of supplementary technologies that push the IoT's boundaries.

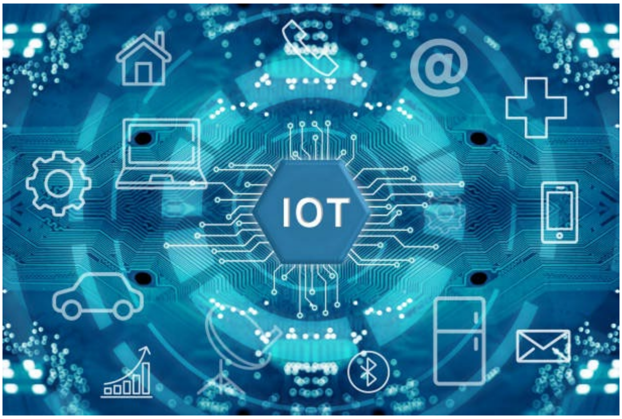

Figure 1.14: Internet of things wireless communication network abstract.

Source: https://media.istockphoto.com/photos/internet-of-things-wireless-communication-network-abstract-image-picture-id1184401187?k=20&m=1184401187&s=612x612&w=0&h=FerMmgqRvMa8mZaDpnggzZjFp4_S2puuQHsuCyFcZtY=

- Artificial intelligence capable of conversing with humans . Internet of Things (IoT) devices, including digital personal assistants like Alexa, Cortana, and Siri, currently offer natural language processing. As a result, household Internet of Things (IoT) gadgets have become more appealing, helpful, and affordable.

Industrial IoT refers to IoT technology that is used in industrial settings to the instrument and run sensors and other cloud-based equipment (IIoT). This Titan case study exemplifies the Internet of Things (IIoT). Recently, the industry has resorted to M2M connectivity to provide wireless automation and control. Cloud computing and related technologies (such as analytics and machine learning) are growing more widespread, which may result in the development of new revenue streams and business models (Bernardes & e Albuquerque, 2003). The Internet of Things is also known as Industry 4.0, or the Fourth Industrial Revolution. Many typical IIoT applications are available here:

- Manufacturing advancements
- Today's electrical grids are more complicated than in previous generations.

Cities with good information

Logistics coordination

- More efficient and productive digital supply chains

Make money from the Internet of Things (IoT)

Businesses are increasingly capitalizing on the immense economic potential of IoT. These advantages also include:

- IoT data insights can be used to improve company management.
  - Increasing workplace productivity and efficiency
- Developing new business ideas and revenue streams
- The capacity to link the real and digital worlds of business smoothly to reduce time to value.

1.11.3 What Are Some Applications Of The Internet of Things (IoT)?

IoT Intelligent Applications are pre-built SaaS apps that can analyze and display IoT sensor data via dashboards for business users. There are numerous sophisticated IoT applications accessible.

Machine learning algorithms can be used to examine sensor data in the cloud. You may monitor crucial performance indicators, statistics for the mean time between failures, and other data with real-time IoT dashboards and alerts. If an abnormality is discovered, machine learning algorithms can alert the user and even initiate automated fixes or preventative measures (Liu & Ihl Woo, 2006).

Cloud-based IoT apps enable organizations to improve their supply chains, customer service, human resources, and financial services in record time. There is no need to start each business procedure from scratch.

1.11.4 How Far Can the Internet of Things (IoT) be Pushed?

The capacity of the Internet of Things to enable and distribute sensor data, as well as device-to-device communication, is driving a wide range of applications. The most frequently utilized application features are documented below.

Monitoring machine and product quality can help to improve production efficiency and productivity.

Machines can be regularly examined and monitored to ensure that they are operating within the parameters established. Another method for identifying and correcting quality issues is to monitor items in real-time(Kobayashi et al., 2019).

Improve your organization's physical asset separation and tracking.

Tracking allows businesses to quickly find their assets. Ring-fencing can be used to protect high-value assets against theft and removal.

Wearables can be used to monitor environmental and health parameters.

IoT wearables enable doctors to remotely monitor patients and improve customer health. Workers in hazardous workplaces can benefit from employers monitoring their employees' health and safety.

Figure 1.15: Kitchen appliances with IoT picture.

Source: https://media.istockphoto.com/photos/kitchen-appliances-with-iot-picture-id1326559943?k=20&m=1326559943&s=612x612&w=0&h=lj9Mql9n1SRbmIO5Vdp_Nx_ygqhk9_yoEiZyGuBY7mM=

Improve current procedures to provide new opportunities and boost operational efficiency.

This is demonstrated through the use of IoT to improve linked logistics for fleet management efficiency and safety. Firms may increase efficiency by utilizing real-time truck guidance given by IoT fleet monitoring (Howe-Walsh & Turnbull, 2016).

When it comes to changes in corporate practices, be adaptable.

To demonstrate this, networked assets can be monitored using IoT devices that initiate service calls for remote components requiring preventive maintenance. Customers can now pay to use a product rather than buy it for the first time, thanks to remote monitoring features.

1.11.5 How May IoT be applied in Various Business Fields?

The IoT would benefit most organizations whose operational processes may profit from the deployment of sensor devices.

- **Manufacturing:** Integrating production-line monitoring to enable proactive repair of equipment when sensors indicate a breakdown provides manufacturers with a competitive advantage. In reality, sensors can detect pauses in industrial output (Hagendijk & Irwin, 2006). Sensor alerts enable companies to swiftly inspect and repair equipment without halting production. This assists the enterprise in decreasing expenses, increasing uptime, and enhancing asset performance management.
- **Automotive:** IoT technology has the potential to provide considerable benefits in the automotive industry. In addition to the benefits of incorporating IoT into industrial operations, sensors in on-the-road cars can identify impending equipment failure and provide the driver with facts and advice. Automotive suppliers and manufacturers have obtained a better understanding of how to keep their vehicles functioning and their customers informed as a result of IoT-based apps.
- **Logistics and Shipping:** Various IoT technologies have the potential to significantly help the logistics and transportation industries. Because of IoT sensor data, it is possible to divert inventory-moving vehicles based on weather conditions or the availability of cars or drivers. Tracking and tracing sensors, as well as temperature monitoring sensors, can be placed directly into the stock (Granato et al., 2014). An IoT-monitoring system for temperature-sensitive products would be extremely beneficial to the food, beverage, floral, and pharmaceutical industries, all of which move temperature-sensitive products regularly.
- **Retail:** Using IoT applications in retail organizations can improve customer experience, streamline the supply chain, and

save expenses. If your smart shelves feature weight sensors, you can utilize an IoT platform to collect RFID-based inventory data and deliver alerts when supplies are running low. Beacons can give customized discounts and incentives to customers to deliver an engaging experience.

- **Profitable Businesses:** The Internet of Things (IoT) has various benefits for the public sector and other service-oriented businesses. Government-owned utilities can use the Internet of Things-based applications to notify customers of major and minor outages in their water, power, or sewer services. IoT apps, for example, can collect data on the scope of an outage and assign resources so that utilities can recover from interruptions more quickly (Grupp & Mogee, 2004).
- **Healthcare:** There are various advantages to monitoring medical IoT assets. Many times, medical workers, such as doctors and nurses, must know exactly where wheelchairs and other patient care equipment should be positioned. Thanks to the Internet of Things (IoT) sensors put in wheelchairs, any patient in need of a wheelchair in a hospital may simply discover the nearest wheelchair that is still in use. Many hospital assets can be tracked with this method, assuring the proper use and financial accounting for each department's physical assets.

Every industry requires consistently high levels of security.

In addition to asset tracking, the Internet of Things can be utilized to improve worker safety. Employees who operate in potentially hazardous locations, such as coal mines or oil and gas fields, must be informed of any potential hazards as a precautionary measure. Individuals who are linked to IoT sensor-based gadgets can be quickly warned or saved. IoT applications are also used in wearables that monitor the environment and human health(Gandini, 2011). These tools can remotely monitor patients and educate people about their health.

1.11.6 What is the Global Impact of IoT? Automobiles With Internet Access Are a Fantastic Example of This.

The Internet of Things is transforming the automotive industry by allowing linked vehicles. Automobile owners can remotely operate their automobiles, such as preheating their vehicles before driving or calling for a vehicle by phone. Because of IoT's potential to promote device-to-device connectivity, automobiles will be able to plan their maintenance appointments in the future.

Figure 1.16: Smart warehouse management system with innovative internet of things.

Source: https://media.istockphoto.com/photos/smart-warehouse-management-system-with-innovative-internet-of-things-picture-id1334427520?k=20&m=1334427520&s=612x612&w=0&h=nVU1kfwQfKqnnkmTgeXmUgHAyIwN-HURliNDdhO6QG5Y=

The linked car enables automakers and dealerships to drastically shift the ownership paradigm. Manufacturers and consumers were rarely (if ever) involved in each other's enterprises in the past (or none at all). When the vehicle was handed over to the dealership, the manufacturer's involvement with it stopped. Connected cars provide continuous communication with customers. Instead of selling automobiles, they may utilize self-driving vehicles to provide "transportation as a service" and charge clients a fee(Breschi & Catalini, 2010). The Internet of Things enables a substantial divergence from the classic automotive ownership paradigm, in which a vehicle's performance and value slowly degrade (IoT).

CHAPTER 2

SCIENCE, TECHNOLOGY, AND INNOVATION (STI) POLICY

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The cornerstones of the United States economy are innovation, research, and development. Furthermore, they are crucial to the growth of modern civilization and the global economy in general. These sectors may be developed to make global governance more democratic, open, and meritocratic.

The State Department uses public diplomacy to promote awareness about the relevance of science in the world today and in the future. It also runs capacity-building initiatives in poor nations, teaching young people how to start their own scientific and technological firms to promote a global innovation ecosystem (Ferrari et al., 2015). Foreign policy goals and economic growth are important priorities for the department, which works hard to encourage scientific initiatives that further these goals.

This section will tell you more about the actions that various agencies are taking to promote this policy topic.

Figure 2.1: Scientists discussing their research.

Source: https://www.istockphoto.com/photo/colleagues-using-digital-tablet-in-laboratory-gm1325053945-410195243?phrase=science%20%2C%20technology%20and%20innovation

Figure 2.2: A functioning tech lab.

Source: https://www.istockphoto.com/photo/cars-on-production-line-in-factory-gm1320950393-407328910?phrase=science%20%2C%20technology%20and%20innovation

STIs are being enhanced all around the world by using a variety of resources and international relationships. The Office of the Science and Technology Advisor to the Secretary of State predicts that STI research and development, as well as high-tech and commercial breakthroughs, will influence foreign policy. Because of its significance, it acts as a vital link between the Department of Health and Human Services and other STI groups both domestically and internationally (Ferguson & Zhang, 2002).

The Office of Space Affairs is responsible for foreign policy and public diplomacy initiatives to promote American leadership in space exploration, applications, and commercialization (SA).

Artificial intelligence (AI) is at the heart of the present technology revolution sweeping the globe. To that end, the State Department works to establish international policy frameworks and collaborations that promote American leadership in artificial intelligence technology, protect our economic security, and advance our values across the globe.

2.1 SCIENCE TECHNOLOGY AND INNOVATION (STI) FUNCTIONS IN GOVERNMENT POLICY MAKING

IRPP and CAE have just released a study on how governments might better incorporate this knowledge into policy-making processes and improve the quality of their decisions to keep up with the rapid advances in science and technology.

It is based on a series of round tables where high-ranking government officials and specialists in engineering, science, and other sectors publicly addressed how governments may better their utilization of scientific research and technical skills in public policy development (Floros et al., 2010). Scientists and technologists must play a larger role in providing a factual foundation for choices and aiding government efforts to reduce risk.

Making study findings more accessible, being more transparent about the evidence used to support a conclusion, and disclosing the criteria that will be utilized to achieve that conclusion are all strategies to promote informed debate.

Making scientific input points more visible in decision-making processes, as well as incorporating these aspects into public service decision-making, can help to strengthen internal policy-making procedures and decision-making infrastructure.

Establish a national scientific and technological advisory committee to advise the government, led by the prime minister.

Maintain a continual interaction between legislators and scientists to ensure that lawmakers have access to objective scientific advice.

Increase and strengthen relationships between the federal government and the scientific community, and make it simpler for citizens to attend conferences, particularly those hosted by for-profit and non-profit groups (Bengisu & Nekhili, 2006).

Develop an international scientific research culture at Global Affairs Canada to reflect the global character of scientific research; expand diplomatic duties in the corporate and public sectors related to science and technology.

The study also advises decision-makers to recognize the importance of carefully weighing scientific findings and other circumstances.

2.2 INTERNATIONAL POLICIES AND GOVERNANCE IN NEW SCIENCE AND TECHNOLOGY

The President of the United States signed the Science and Technology Basic Law into law on November 15, 1995. The purpose, as stated in the law, is to increase the bar for science and technology through promoting initiatives such as the implementation of the Science and Technology Basic Plan, among others. Science and technology play an important role in Japan's economic and social growth, as well as in improving the nation's well-being and the long-term development of human society, and this law is founded on this awareness (Bell & Lederman, 2003).

The government must implement a basic plan for science and technology development, as prescribed by Article 9 of the Constitution.

Figure 2.3: A scientist showing her work to her fellow scientist.

Source: https://www.istockphoto.com/photo/science-laboratory-gm587802854-100909981?phrase=science%20%2C%20technology%20and%20innovation

Japan created and implemented the Second Science and Technology Basic Plan during the protracted period of economic stagnation that followed the collapse of the bubble economy. The Cabinet approved it in March of that year. Despite the worsening economic climate, government spending on research and development has increased, and several structural reforms have been implemented, including setting strategic priorities in science and technology by promoting basic research and prioritizing research and development activities on topics of interest to the government and society; creating a competitive R&D environment by increasing competition (Foest et al., 2006).

Figure 2.4: A team of researchers doing their work.

Source: https://www.istockphoto.com/photo/team-of-computer-engineers-lean-on-the-desk-and-choose-printed-circuit-boards-to-work-gm968289874-264025997?phrase=science%20%2C%20technology%20and%20innovation

The Second Basic Plan's key themes were "a nation contributing to the world through the development and utilization of scientific knowledge," "a nation with international competitiveness and the potential for sustained expansion," and "a nation assuring safety and quality." Science and technology (S&T) must be publicly funded to serve society, and the Basic Plan places a high value on developing human capital and creating competitive research environments. The Basic Plan's six policy objectives are more explicit than the plan's ideals. Advances in modern science and technology;

Economic development and environmental preservation; Japan as a pioneer; Long-term good health of the country; and the world's safest country. High-quality basic research should be concentrated on four areas, according to the Fundamental Plan: biological sciences, information and telecommunications, environmental sciences, and nanotechnology/materials. The Basic Plan promotes inter-sector prioritization by defining "strategic science and technology" that requires considerable investment during the plan's duration and suggesting promotion techniques for each of the plan's eight categories. There is also mention of addressing some policy issues in science and technology over the next five years, such as creating a large pool of highly qualified researchers, creating and maintaining a competitive environment, and removing institutional and practical barriers to research dissemination. Advocating for financial structural reforms that address both revenues and expenditures is critical to developing a proactive society, thriving economy, and maintaining Japan's long-term progress (Dhillon et al., 2017). The fundamental strategy for this year has the objective of raising government R&D spending to equal that of major European nations and the United States in terms of R&D spending as a proportion of GDP. From fiscal 2006 through fiscal 2010, the government must invest around 25 trillion yen in R&D.

Throughout the Basic Plan implementation period, government R&D investment is expected to equal 1% of GDP, with nominal GDP growth of 3.1 percent.

Figure 2.5: An infographic on technology.

Source: https://www.istockphoto.com/vector/artificial-intelligence-controlling-robotic-arms-gm1203139711-345678093?phrase=science%20%2C%20technology%20and%20innovation

As a result, to maximize the positive impact of government R&D investment through consistent implementation, taking into account future social and economic trends, the need to promote science and technology, and fiscal conditions even worse than during the Second Basic Plan's period, Japan should work to increase the funds required to promote the policies outlined in the Basic Plan (Doi, 2006).

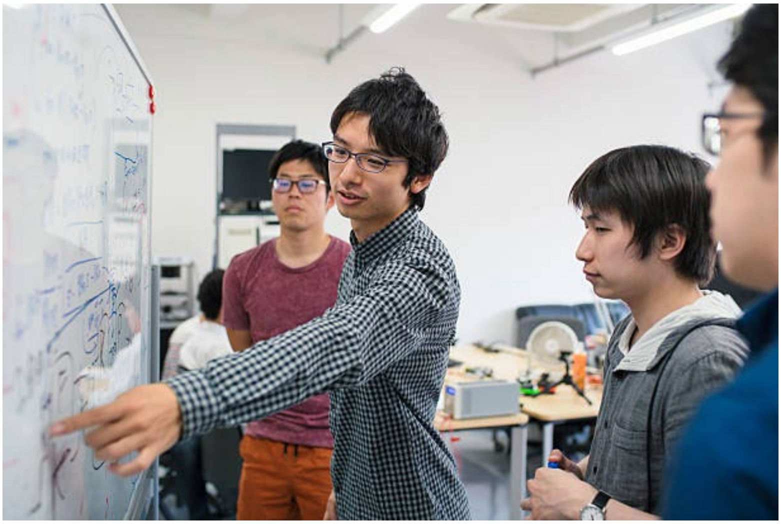

Figure 2.6: A team of researchers explaining their work.

Source: https://www.istockphoto.com/photo/students-looking-at-scientific-formula-gm547043084-98777109?phrase=science%20%2C%20technology%20and%20innovation

Science and Technology Policy Council: Since its inception in January 2001, the Prime Minister has presided over the Council for Science and Technology Policy. The Council convenes once a month.

The following is a summary of the most significant topics argued and passed during the 2001 fiscal year.

(1) Modifications to the Science and Technology Budget for 2006.

In Fiscal 2006, the Council boosted its efforts for high-quality measures by encouraging the reform of the science and technology-related budget, including the adoption of "core business concentration," to make the budget fit for the first year (Cao et al., 2006).

Council members and the Minister of State for Science and Technology Policy compiled opinions on their primary science and technology-related projects for independent administrative institutions, among other things, after consulting with outside experts, and then ranked the initiatives in science and technology for which the relevant ministries and agencies submitted budget requests. The priority’s conclusions were as follows:

Implementation of critical research (S:24 items, 12 percent)

A: Seventy-two items (or 37% of the total) are key research topics that must be implemented continuingly.

B: 78 different goods (40 percent) A lot of difficulties must be addressed and appropriately carried out.

Items C:19 necessitate a reevaluation of research objectives, specifics, and promotion methods (10 percent).

The S group received 28 percent of the entire budget, with 34 percent going to A, 35 percent going to B, and 36 percent going to C. (35 percent). 3% of the total population

The CSTP outlined “Toward Formation of the Fiscal 2006 Scientific and Technology-Related Budget (Opinion)” and delivered its opinion to the Prime Minister and the competent ministers(Chadwick et al., 2011).

Despite a decrease in total spending, costs for science and technology promotion increased by 1.1 percent, since the government views it as an “investment in the future.” R&D spending, including non-marketing costs, declined by 0.1 percent.

Knowledge about scientific and technological endeavors undertaken by autonomous government agencies and national institutions, as well as the distribution of proposals relating to these activities;

The compilation of “Comprehension of Science and Technology Activities Conducted by Independent Administrative Institutions and National Universities, and the Publication of Opinions Offered Regarding the Activities” began to understand the science and technology-related activities carried out by institutions that rely primarily on difficult-to-distribute grants for administration.

The endeavor to combine scientific and technological initiatives is becoming well known.

The Coordination Program for Science and Technology Projects was promoted for the eight national and socially significant themes listed below, which should be promoted with collaboration between relevant ministries and agencies as a new way to combat the negative effects of sectionalism and improve collaboration: RFID technology and tags in ubiquitous networks; Biomass use; Shared platform technology for future robotics; Nanobiotechnology; Hydrogen and Fuel Cell Technology; Regional Cluster; and Nanotechnology are all instances of health sciences post-genome promotion(Borup et al., 2006).

Adequate finance for competitive research needs both broad changes and more specific increases.

To foster creative R&D activities, a competitive R&D environment must be established. To achieve this aim, extensive institutional reform has been implemented to optimize the impact of competitive research funding. Furthermore, financial increase and more effective funding distribution have been achieved by preventing R&D projects from becoming unduly concentrated and eliminating needless resource duplication.

Guidelines for distributing funding and staff for scientific and technological research and development

The CSTP is charged with reviewing proposed science and technology policies for the next fiscal year in light of the Basic Plan, sectoral promotion plan, and other documents. It then makes recommendations to the Prime Minister on which policies it considers should be prioritized and explains its views on resource allocation for the forthcoming fiscal year before presenting them to the re-elected government (Zhang et al., 2018). Furthermore, the council collaborates with the financial authorities to ensure that the resource allocations decided by the CSTP are executed during the budget preparation process.

Budget and Human Resource Allocation Recommendations for Science and Technology Research and Development with Commentary

The guidelines emphasize the importance of establishing strategic goals based on “selection and concentration” following directives such as

- Science and technology should be supported by the public and serve the public good,
- Third Basic Plan for Science and Technology principles and policy objectives, and
- The importance of human resource development and the competitive landscape.

The suggestions highlighted particular subjects to be emphasized 1. Strategic science and technology priority planning. 2. The fostering of scientific and technological system improvements; and 3. Societal and public support for research and technology

An examination of promotional activities in major areas

The CSTP developed a "Sectoral Promotion Strategy" based on the prioritized strategies for eight major fields in the Basic Plan, including life sciences, information and communications, environmental sciences, nanotechnology/materials, energy, manufacturing technology, social infrastructure, and frontier—outer space and the oceans". To address these difficulties, the CSTP suggests marketing-based initiatives.

To advance nanotechnology and materials.

To stimulate R&D and industrialization in the domains of nanotechnology and materials, the Council has been executing initiatives for the "usage of structural materials in the building market" as "collaborative projects" involving ministries and agencies. The "Report on Promoting Industrial Development in Nanotechnology and Materials Area" serves as a foundation for this. The Council's Coordination Program for Science and Technology Projects funds research on technologies that combine nanotechnology and biotechnology (Zeldin et al., 2008).

Following up on large-scale R&D project assessments, the Council reviewed the evaluations of major R&D projects implemented and presented improvements to the relevant ministries.

Midterm reviews are required for all ongoing R&D initiatives with funding of over 1 billion yen. The Minister of Science and Technology Policy, as well as other prominent members of the council, reviewed the findings of this assessment. As a result, ministries and agencies were recognized for their proactive efforts, as they had been the previous year. While midterm and long-term assessments were less common in the current year's research, the number of scenarios where they were completed the previous year increased. The Minister and Council members advised ministries and agencies on how to conduct timely midterm evaluations following the purpose and theme of each R&D problem and action.

The Council for Science and Technology Policy implemented a new set of criteria for determining whether R&D projects are of national significance.

The Council agreed on ex-ante and ex-post assessments, as well as midterm reviews, for large-scale R&D initiatives.

2.3 THE MOST RECENT AND SIGNIFICANT R&D EFFORTS

The Council looked into X-ray free electron lasers, high-performance general-purpose computers, and the Strategic Promotion of Advanced Basic Technologies Project, all of which began and cost at least 30 billion yen in total. The Council then forwarded its findings to the appropriate ministries) (Wu et al., 2019).

The "Report on the Management of Intellectual Properties" focuses on intellectual property management.

The Council's recommendations on how universities and colleges can best proactively use intellectual property were shared with the relevant ministries.

The scientific, technical, and professional personnel required to accelerate high-level research breakthroughs were investigated. The Council then informed the relevant ministers of its findings and conclusions. The study recommends higher education, primary and secondary education, as well as research and educational environments that foster the development of creative values.

Reaction to the Basic Conceptual Approach Regarding the Treatment of Human Embryos.

The Council of Europe is currently debating human embryonic stem cell research under the Supplementary Provisions to the "Law Concerning Regulation Relating to Human Cloning Technologies and Other Similar Technologies." Finally, the recommendations of the Council were communicated to the relevant ministers. According to the findings of this study, human embryos must be treated with extreme caution in certain circumstances if people's health and well-being are to be protected(Woolgar & Lezaun, 2013). The report makes it illegal to handle human embryos in a way that harms them from the start.

Following recent changes in domestic and international conditions surrounding space development and use, the Council expressed its views on the importance of space development and use, including the importance of space as a national strategic technology, contribution to overall national security, and contribution to the Earth's and humanity's sustainable development. The Council of Ministers The report recommends that Japan maintain its capacity to launch satellites as needed and emphasize dependability to promote space development and use

Figure 2.7: New technologies at work.

Source: https://www.istockphoto.com/photo/robot-arm-gm1022237064-274458802?phrase=science%20%2C%20technology%20and%20innovation

2.4 PROMOTION OF RESEARCH AND TECHNOLOGY AIMED AT IMPROVING PUBLIC SAFETY

Because of the increased frequency and severity of incidents posing a threat to public safety, such as large-scale natural disasters, various forms of terrorism, violent crimes, and emerging or re-emerging infectious diseases, it is critical to strengthen the nation's crisis management system and create a safe society (Wang, 2009). Since the Expert Panel on Promoting Priority Areas established the Project Team for Promotion of Science and Innovation for Security and Safety, scientists and technologists have been working to create a fearless society.

Chosei-hi is a competitive research fund that promotes systematic reform of science and technology by implementing policies that become policy proposals for every other administrative agency based on the CSTP principles. The Special Coordinator supported the Research on Damage Caused by the Sumatran Earthquake and Indian Ocean Tsunami, the

Emergency Survey Research on Countermeasures Against Asbesto, and the Emergency Survey Research on Production of New Influenza Vaccine.

The Third Science and Technology Basic Plan is being prepared as a follow-up to the Second Science and Technology Basic Plan's "Progress of Scientific and Technological Policies Based on the Science and Technology Basic Plan.

Figure 2.8: A team of researchers analyzing their new tech.

Source: https://www.istockphoto.com/photo/caucasian-male-and-black-female-engineers-working-on-a-drone-project-with-help-of-gm1167549790-322024229?phrase=science%20%2C%20technology%20and%20innovation

Following the three-year implementation phase of the Second Science and Technology Basic Plan, the Council conducted an extensive follow-up study on the state of measures implemented and issued a list of fundamental problems that should be addressed in the future.

The National Institute of Science and Technology Policy conducted an additional study, the "Survey for Evaluation of Effects Achieved in the Basic Plan," with funds from the Fiscal 2003-2004 Special Coordination Funds for Promoting Science and Technology.

The Third Basic Plan for Science and Technology is Being Developed.

The Council for Science and Technology Policy, which is mandated by law to formulate the basic policies on science and technology that serve as the basis for the Science and Technology Basic Plan, established this panel to prepare the Third Science and Technology Basic Plan for five years. Academics and professionals from a variety of professions, including international politics, national security, economics, fiscal policy, and law, make up the Expert Panel. Following the Prime Minister's directive to examine the “Japan’s Science and Technology Fundamental Policy Report,” the task force conducted research and analysis on basic policies influencing science and technology before suggested. Following the announcement of the recommendation, the Cabinet accepted the Third Science and Technology Basic Plan(Wynne, 2007). The Council created the following eight key sectors as part of its “Sectoral Promotion Strategy”: biological sciences, information and communications, environmental sciences, nanotechnology/materials, energy, MONODZUKURI (manufacturing) technology, social infrastructure, and the frontier.

2.5 ORGANIZATIONAL STRUCTURE AND BUDGET OF SCIENCE AND TECHNOLOGY

2.5.1 Organizational Structure of Science and Technology

While the country’s science and technology policy is largely based on two pieces of legislation — the Fundamental Law on Science and Technology and the Basic Plan for Science and Technology in Japan — it also heavily relies on programs developed by government agencies, which are informed by the CSTP. Researchers use a range of research programs to operate in several research environments, including national research institutes, governmental companies and agencies, academic institutions, and university-affiliated research centers.

Coordinates the implementation of science- and technology-related measures by relevant ministries and agencies under the Prime Minister’s leadership by examining and discussing basic science and technology policies, budget allocation policies, human resources, and other resources related to science and technology, and so on. A proposal to build Japan’s Science and Technology Basic Plan was given to the Prime Minister and was referred to as the “Japan’s Science and Technology Basic Policy Report” (STBPR). The Ministry of Education, Culture, Sports, Science, and Technology prepares individual sector research and development plans following these strategies, and the SCF (Special Coordination Fund for Promoting Science and Technology) is administered by the SCF to facilitate the coordination of science and technology management with relevant administrative institutions (Woellert et al., 2011). The Ministry of Scientific and Technology significantly supports research and development in cutting-edge science and technology sectors, as well as science and technology administration that develops and enhances creative research.

In recent years, ministry-agency cooperation has been strengthened through the formation of roundtable groups and inter-ministerial liaison committees for various research sectors and measures, such as programs to promote brain science research and basic research conducted by public corporations using public canvassing methods. Each of these programs encourages lateral thinking across ministries and agencies, the acceptance of priority suggestions on how to improve R&D, collaboration through promoting information exchanges about research progress, etc., and researcher exchanges.

- The Science Council conducts surveys and debates on major subjects connected to the holistic promotion of science and technology in response to inquiries from the Minister of Education, Culture, Sports, Science, and Technology, and gives opinions to the minister.
- Principal's Reports
- Funding for scientific and technical research
- The Second Basic Plan's purpose is to expand the resources needed to support the activities listed in the Basic Plan, while also considering future socioeconomic trends and the necessity of improving science and technology.
- To guarantee uniformity among ministries and to successfully promote science and technology, science and technology administration in Japan must be coordinated across a vast number of ministries and agencies. This will reduce redundancy and improve collaboration among the various departments and agencies.

As a result, the Council for Science and Technology Policy works to ensure that the key measures outlined in the Science and Technology Basic Plan are effectively implemented throughout Japan by developing policies on the allocation of budget, human resources, and other resources related to science and technology, as well as prioritizing science and technology-related measures of relevant ministries and agencies after the budget. Every year, before revealing budget proposals for science and technology expenditures, the Ministry of Education, Culture, Sports, Science, and Technology contacts the relevant ministries to learn about their budgetary demands (Whitcombe et al., 2014). As part of government-wide efforts, it then collaborates with other departments and agencies to decrease redundancy and increase cross-ministerial collaboration.

2.6 STI POLICIES IN PROMOTING SUSTAINABLE DEVELOPMENT

The Rio+20 meeting is largely expected to result in the Sustainable Development Goals (SDGs). Colombia's southern and northern governments have supported this concept since its beginnings. Furthermore, the "zero drafts" paper and the UN expert panel on global sustainability's most pressing problems were widely highlighted at conferences (UN GSP). It is now assumed that the SDGs will fill the void left by the MDGs' 2015 targets in terms of economic and environmental activities, as well as methods of thinking. The most recent conference of the New York Center for International Cooperation highlighted the lack of agreement on the scope, target audiences, and actual implementation of the SDGs (Verbeek et al., 2002). The SDGs should address a wide variety of challenges, including those related to the economy (such as employment and consumption), society (such as poverty, education, health, and gender equity), and the environment (climate change, water, and ecosystems). (For example, climate change, water, and ecosystems). According to the Center for STEPS, the Resilience Center of Stockholm, and the Institute of Tellus, a "safe operating zone" for human society is urgently needed at this time.

Figure 2.9: An infographic on creative thinking.

Source: https://www.istockphoto.com/vector/creative-thinking-line-icon-gm861275520-142543781?phrase=science%20%2C%20technology%20and%20innovation

They contend that the SDGs, which provide a policy framework encompassing all areas of SD, must be thoroughly incorporated into the industry, government, and individual decision-making. Given that the global climate is in crisis and is anticipated to worsen by 1.40 to 5.80 degrees Celsius by the end of the twenty-first century, we are reaching tipping points in terms of climate change. The risks and vulnerabilities connected with the current condition of the global climate are substantial, but there is also the possibility of socio-technical system changes and adaptations.

To thrive, all of these systems must be constructed on a basis of long-term global sustainability. Sociotechnical system transformation is essential (which was defined as "socio-technical system change") 1 Renewable energy sources might be introduced with the support of STI policy. Low-carbon and inclusive economies will remain elusive if renewable energy is simply viewed as a replacement for conventional energy and conventional energy continues to dominate the country's innovation system(Terrones, 2003). Although industrial structures may evolve, the ambitious SDGs will remain a pipe dream. Energy is merely one of several crucial economic sectors. An environment in which energy, a crucial component of the environment, has a large impact on the global economy.

Figure 2.10: A young scientist using the virtual reality technology.

Source: https://www.istockphoto.com/photo/in-a-computer-science-class-boy-wearing-virtual-reality-headset-works-in-interactive-gm1089737754-292337460?phrase=science%20%2C%20technology%20and%20innovation

Transforming society to be more environmentally friendly, often known as “radical transformation” toward a sustainable society, is a strategy that tries to address many of the problems that modern societies confront. Internalizing environmental costs, on the other hand, is not an entirely novel concept. As a result of increased awareness about the environmental impact of sustainable economic growth, there has been an increase in environmental sustainability consciousness since the 1970s.

Limits to Growth concept is one of the cornerstones of sustainability research. Based on this concept, a group of academics developed a global inclusive model that depicts global viewpoints that are both locally relevant and socially beneficial. This concept involves numerous complex systems at the same time. While the model replicates many elements of economic and environmental difficulties, it also considers how these factors interact. As a result, modeling multiple policy scenarios invariably leads to the same conclusion: global climate change might have disastrous consequences for the environment and society if current trends continue. Environmental economists began to question if environmental costs were being unfairly externalized in the course of economic development as early as the 1970s. He advocated for a stable economy with growth that did not exceed a certain threshold to ensure the sustainability of the world’s resources.

When the World Commission on Environment and Development delivered the Brundlandt report to the United Nations in 1987, an important milestone was reached. Until recently, the notions of “development” and “environment” in sustainability theory were not mutually incompatible (Sismondo, 2018). Sustainable development was defined as “meeting the requirements of the present without risking future generations’ ability to meet their own needs.”

According to this study, sustainable growth is limited by the planet’s ability to absorb the consequences of human activities, technological breakthroughs, and social institutions all at once. The development of social institutions and technological developments provide future growth potential. Long-term economic growth is regarded as critical in the twenty-first century. But it won’t happen by itself. As a result, given the scarcity of timely and effective policy solutions to sustainability, researchers assert that policymaking needs a scientifically informed analytical framework. As a first step toward sustainable energy, “transformational innovation policy” design and implementation must be hastened.

As a result, it is advised that STI policies be employed in combination with a new transformation system that emphasizes renewable energy sources above traditional sources such as sun, wind, hydropower, geothermal, ocean, hydrogen, and biomass. That is what we mean by the transformation of socio-technical systems, which comprises social, behavioral, and technological change occurring concurrently. The term "socio-technical system transformation" (or "transition") refers to a considerable change in the way all social components interact with high-tech solutions and legacy technological advancement (i.e., changing industrial structure, infrastructure, abilities, consumer preferences, law, and rules, as well as cultural predilections). Legislation that supports and encourages systemic transformation.

Because of the increased awareness of the need to stabilize GHG emission concentrations and meet the 1.5 to 2.0 C global target, governments all over the world have made this type of regulation a top policy priority. This approach includes innovation methods, new partnership models, and new governance structures, as well as the introduction of new markets and changes to organizational, institutional, and monitoring behavior. The United Nations Environment Programme has recently pushed for innovation, and governments, corporations, and non-governmental organizations are all in agreement that it is critical to the transition from unsustainable to sustainable development (Shannon et al., 2010). Twenty years ago, the "advanced" Global North's "green economy" narrative focused on innovation as a market-driven process. Furthermore, it is past time for economic debates to include social and environmental concerns.

When we recognize that there is no way to address the economy-environment problem without changing our output and consumption levels, as well as our global relationships. To combat climate change, influential policy circles must drastically alter the way we currently consume and produce energy for the sake of our planet's future. The Stern review introduced a broader concept of "managing the transformative shift in energy," using new academic activities as examples. Despite being primarily technological, Stern research provided an economic justification for policy innovations that deviated from market-led, generic, gradual, and equitable technological resolution. As a result of the market failure that caused climate change, there is a need for an even more profound technological revolution that "could not be provided by markets." To meet national goals for a sustainable energy economy, early-stage deployment support for technology-based deployment is required (Suryanarayana et al., 2001). The concept of transition was introduced at the policy level when it came time to develop a state-led, sustainable innovation strategy. “Energy efficiency” and “low-carbon alternatives” to renewable energy generation are two examples of innovation required to reduce emissions, and both consumers and producers will be involved.

First, the Paris Climate Agreements identified innovation as a critical driver in both developed and developing countries to enable and accelerate the global energy revolution toward sustainability. S&T, on the other hand, is critical to many of Agenda 2030’s sectoral goals. According to recent experience, STI policy in most of the world’s largest economies (including India, China, and the EU) has demonstrated that the system can “serve as a basis of strategic knowledge” to combat the threat of climate change due to its strength not only for increasing productivity, prosperity, and economic development but also for environmental sustainability. The Addis Ababa Action Agenda (AAAA) recognizes that “the establishment, development, and dissemination of new technologies and innovations, including technology transfer on mutually agreed-upon terms, are influential drivers for moving toward a sustainable world”. Technological advancements will not drive all of these advancements.

To deal with uncertainty and open up new avenues and opportunities for the future, the current economic, social, and environmental systems must be drastically restructured. Without STI, such a structural change would be impossible. Furthermore, the Innovation Policy stressed that sustainability cannot be achieved simply by extending or modifying existing systems. However, encouraging STI alone will not suffice for sustainable energy development; unprecedented collaboration is required to facilitate governance and policy environments, increase human capacity for innovation, make effective use of public financing and mobilization, maximize the positive impact of mitigation, and conduct continuous monitoring and evaluation of the results achieved (Swierstra & Rip, 2007). New theoretical frameworks in the disciplines of sustainability transition and transformative innovation policy must be integrated into an overall policy agenda focused on sustainability.

A key component of a positive governance environment is the incorporation of STI policies into larger sectoral plans and policies. Furthermore, these constraints may help to create an environment conducive to transformation. The strategy’s benefits include increased economic and environmental efficiency, as well as the development of long-term solutions to meet societal energy demands (e.g. biotech for smallholders, clean cooking stoves). As a result, the plan establishes the groundwork for a new global alliance, ushering in a new era of cooperation and harmony. Working more closely with researchers and innovators in the developed world, development partners may be able to help nations like Africa shift to more sustainable growth patterns, such as renewable energy, by transferring cutting-edge technologies. It is also possible to increase public-private R&D expenditure and investment by fostering public-private partnerships and collaborative R&D with developed nations (Small, & Klavans, 2014). The Sustainable Development Goals (or "STI4SD") are one of the factors that can change the trajectory of the global economy. They may thus play an important role in future national legislation as well as the basis for international community discussions on how to achieve the SDGs.

Figure 2.11: New technology being analyzed.

Source: https://www.istockphoto.com/photo/helpful-teacher-works-with-students-in-technology-class-gm659083136-120250109?phrase=science%20%2C%20technology%20and%20innovation

2.7 STRENGTHENING THE TECHNOLOGICAL CAPABILITIES OF DEVELOPING COUNTRIES

Many governments in developing nations recognize the need of being able to detect, adapt, and use industrialized countries' S&T discoveries while simultaneously developing their distinctive technologies. According to World Bank experts, these countries are growing increasingly reliant on aid in science and technology.

Figure 2.12: Young kids practicing innovation.

Source: https://www.istockphoto.com/photo/students-building-windmill-during-elementary-science-class-gm505018812-83460405?phrase=science%20%2C%20technology%20and%20innovation

Pest-resistant crops and less wasteful food processing, for example, can all be improved through better application of widely interconnected technologies, as can prenatal care and child health, disease prevention and treatment, environmental contamination reduction, water filtration, more dependable electric power, more effective communication systems, and cheaper transportation systems. USAID programs, notably export promotion and administration, are linked with developing nations' regional S&T competence (Rogers & Marres, 2000).

A 1983 USAID strategy for institution development that is still relevant today emphasizes the importance of S&T skills in developing nations. The regulations were as follows:

- The generation, adaptation, and transmission of information and technology at the global, national, and local levels is crucial to the development process.
- Transfer of science and technology is more effective in nations with scientific bodies capable of analyzing and adapting knowledge and technology to local conditions.
- As a result, establishing local institutions capable of accessing and contributing to the global knowledge supply must be a top priority for USAID.

2.8 USAID. A USAID POLICY DOCUMENT ON INSTITUTIONAL DEVELOPMENT. USAID, WASHINGTON, DC.

The reference is “3 Strengthening the Science and Technology Capacity of Developing Countries,” according to the citation. The National Academy of Sciences is a scientific organization. Science and technology are critical components of international development. The National Academies Press, Washington, D.C.

There are significant variances across countries in the kind of technology that are most suited to tackling development concerns. Long-standing medical, agricultural, and technical achievements may be more feasible than more recent advancements that are gaining popularity in developed countries. A nation’s ability to pick the technology that can be properly deployed and maintained at an acceptable pace by its government and, increasingly, private sector entities is a crucial aspect of successful growth.

There is a danger that countries’ economic, educational, and scientific goals would fail to appropriately reflect the requirement to develop S&T competency. When it comes to policies that encourage government and private sector organizations to invest in appropriate technology, support training initiatives for local suppliers and users of technologies and guarantee that product quality criteria are satisfied, they are frequently disregarded. Because of a lack of understanding about the capabilities and limits of the technology being acquired, both public and private sector organizations are more likely to buy what outside salespeople sell them or adopt suggestions from abroad partners(Rao & Cheetham, 2001). Governments around the developing world are actively working to increase their technical capabilities so that they may pick and adjust both domestic and imported technology to ensure that it performs effectively in the physical, economic, and social contexts in which it is used. Local specialists can often give critical assistance in the choosing process.

The United States Agency for International Development (USAID) has made substantial contributions to the development of a river-level monitoring system in Bangladesh. Every year, hundreds of individuals living in flood-prone areas are spared because of these and other initiatives from the government and others, Unpublished report from the NRC Committee on Science and Technology in Foreign Assistance field trip to Bangladesh.

Every year, in a region where millions of lives are at risk, the need for local capabilities to effectively implement technology that may provide early warning of natural disasters and enable rapid and efficient disaster response is demonstrated(Porada et al., 2013). Even though USAID has a long history of assisting in the deployment of cutting-edge technologies in the aftermath of natural disasters, it has not focused as much on strengthening national capacities for anticipating and responding to such events once international support teams have left the scene. Boxes 3-1 and 3-2 include two instances of how people responded to the task.

The reference is “3 Strengthening the Science and Technology Capacity of Developing Countries,” according to the citation. The National Academy of Sciences is a scientific organization. 2006. Science and technology are critical components of international development. The National Academies Press, Washington, D.C.

Many nations acknowledge the value of higher education in science and technology (S&T), which is yet another crucial field. There are no well-established institutions in most poor nations to provide this sort of training. A shortage of trained S&T professors is also an issue in both institutions and colleges.

Although storms constitute a considerable economic risk, satellite technology has the potential to considerably enhance our existing ability to anticipate their direction and timing. However, storm-prone Central American countries are unable to make use of this new technology.

March 2005 field report from Central America by the NRC Committee on Science and Technology in Foreign Assistance (SOURCE: An unpublished field trip report).

The forms of funding that are acceptable for local researchers in the development process vary greatly among nations. If a country cannot afford to support its research center, regional efforts may be considered. Regional education and research institutes have attracted a lot of attention, particularly in Africa. It may be simpler for larger countries to establish their skills. Foreign investors must recognize that, whether they are establishing a national or regional education or research center, long-term investments are essential (Pahlavan & Makela, 2002). Generous benefactors sometimes only support new research and educational facilities for a limited time. It is then up to the researchers to determine how to proceed in the absence of long-term financial commitments, which can swiftly ruin promising research endeavors.

The United States Agency for International Development (USAID) has had a substantial influence on the research capacity of various universities and research institutions throughout the world over the years. For example, by employing American land grant schools, the United States Agency for International Development (USAID) has worked with analogous institutions in the developing world. These efforts have had a significant impact for 10 or more years. As a result, the education of Mexican and Brazilian plant geneticists has resulted in huge gains in the development of crops that can endure unfavorable climatic circumstances. USAID’s financing for local science and technology educational institutions has declined significantly in recent years.

- The agency has slashed scholarships, infrastructure, and commodities. We need to reintroduce some of these weapons into our arsenal.
- Administrator of the United States Agency for International Development (USAID), Long-term commitments by USAID to assist local institutions for a decade or more have mostly been supplanted with short-term programs(Otsuka & Kakeshita, 2002).
- The reference is “3 Strengthening the Science and Technology Capacity of Developing Countries,” according to the citation. The National Academy of Sciences is a scientific organization.

Science and technology are critical components of international development. The National Academies Press, Washington, D.C.

- This project has a maximum period of five years or less. Students from impoverished countries studying at US institutions with USAID assistance have dropped tenfold in the previous three decades, which is understandable considering the hardships they experience at home. Box 3-4 illustrates the detrimental impact on Mali of this drop in support for higher education.
- The decision by USAID to devote all of its educational resources in Mali to primary education while ignoring higher education has had a devastating effect on the viability of local universities, which are still in the early stages of development, as well as the influx of internationally-trained professionals into positions of leadership in the government.

Effective, extensive S&T education in American universities is only one aspect of institutional development. Researchers who have recently completed their training require appropriate facilities to put their knowledge to use. Potential customers may waste time if they are uninterested in the researchers' work. Specialized training in the United States or other relevant countries, on the other hand, can provide a solid foundation for the long-term improvement of local skills. Developing human resources must be the top priority if nations are to be able to adapt, innovate, and implement technological innovations critical to their long-term economic survival (Nisbet et al., 2002). It is impossible to overestimate the importance of networks developed through training in the United States for the promotion of American interests.

In recent decades, there has been a lot of interest in the possibility of connecting more developed developing countries with other developing countries through South-South technology transfer. Collaboration between Israeli and other Middle Eastern experts may be the best example of the type of effort that USAID is now encouraging. Despite its political motivations, this project has resulted in several scientifically useful connections.

For some societies, the most important type of connectedness is the kinship that naturally develops between scientists and engineers working in the same fields. USAID has funded activities between chemical societies in several countries interested in researching natural goods business opportunities (for example, in tropical areas) (Antal & Grønli, 2003). These connections are frequently important for identifying economic opportunities and preventing scientists in developing countries from becoming estranged from their counterparts in the developed world and, as a result, losing research interest.

Given the importance of improving S&T capabilities in virtually all developing countries, USAID should refrain from cutting back on its contributions.

“3 Enhancing Developing Countries’ Science and Technology Capabilities,” National Science Foundation, 2006. The Fundamental Role of Science and Technology in International Development: A Need for the United States, International Development Agency, National Academies Press, Washington, D.C.

To improve S&T skills in critical development industries in developing countries:

To accomplish this, USAID must look at the following-

1. Increase the number of students enrolled in intensive USAID-funded graduate programs aimed at developing future leaders in various S&T disciplines. For the aforementioned reasons, the possibilities for USAID-supported study at US institutions should be dramatically increased, perhaps by a factor of two to three, while acknowledging that the number of students will not reach the significantly higher levels of the 1980s. The emphasis should be on education, which can directly assist activities in the energy, environment, agriculture, and health sectors, as well as other USAID and developing country priority priorities. Visa restrictions, brain drain incentives, and American concerns about terrorist networks entering the country will all limit the spread of this training. However, USAID projects have repeatedly demonstrated the importance of educating future S&T leaders at American universities (Moore, 2013). Such training should be revitalized by utilizing tried-and-true sandwich programs that divide time between study abroad and fieldwork at home, as well as other tried-and-true tactics that draw researchers’ attention to ongoing concerns in their own countries.

Graduate training programs in the United States should be supplemented with the following: (1) graduate training programs at strong regional and local institutions; (2) opportunities for local specialists to participate in Web-based distance learning programs; (3) short-term trips to the United

States for conferences and short-term training courses; and (4) increased use of training partnerships with the country's private sector. Such training programs must be closely linked to USAID's priority areas of interest in the participants' home countries. Participants in training programs should be drawn from as many institutions as possible to strengthen both institutional and individual capacities.

Long-term training both at home and abroad must be balanced, but this must be done on a programmatic and national level. It is critical to consider the consequences of obtaining a degree in the United States, which frequently leave graduates with a strong attachment to the country and encourage American educators to research international development-related topics.

2. Increase funding for applied research and community involvement at regional institutions that may support USAID priorities in the host country, particularly extension. Strengthening applied research and outreach skills at key institutions may result in short-term discoveries, ensure the long-term viability of USAID projects through local efforts, and promote local economic growth.

"3 Enhancing Developing Countries' Science and Technology Capabilities," National Science Foundation, 2006. Science and Technology's Critical Role in International Development: An American Obligation International Development Agency

Zeal for education. Furthermore, academics are frequently involved in government decisions regarding the importation of foreign technology. The first chapter provides some examples of USAID's previous accomplishments in fostering agricultural and health research and outreach (MacIá, 2005). Model programs that pique the interest of researchers from across the country are frequently critical for addressing national concerns.

USAID has had a significant impact on the development of economic and human resource research departments in several countries, particularly within government ministries. To evaluate the success factors, consider USAID's experience in establishing large research capacities in areas other than health and agriculture. Furthermore, USAID has aided in the transformation of underperforming government-funded industrial research institutions into important centers of technological innovation (e.g., institutes in India and Guatemala). In other cases, however, USAID terminated the initiatives due to a lack of immediate results, which hampered short-term progress. It is also critical to show that short-term initiatives are ineffective.

A recently established program to assist Pakistani scientists is an example of USAID support for regional S&T capacity-building efforts. The Pakistani government provides up to $3.5 million per year to local S&T teams, while USAID provides $2 million for American collaborators and administrative assistance. Applications in Pakistan and the United States are subject to peer review, and awards are based on open competition (Martin, 2010). Although it is too early to assess the program's success, early indications suggest that funding will allow key Pakistani organizations and their scientists to play larger roles in the country's development.

The preceding discussion of applied research and extension was primarily focused on government-funded initiatives. Governments should devote more resources to fostering innovation because the private sector is responsible for a large portion of it (e.g., tax incentives, provision of technoparks and other suitable working areas, and training of private sector employees). In terms of financial incentives, governments could provide matching funds to leverage private investments in technical innovation, as well as financial assistance to technology-focused start-ups struggling to secure market niches.

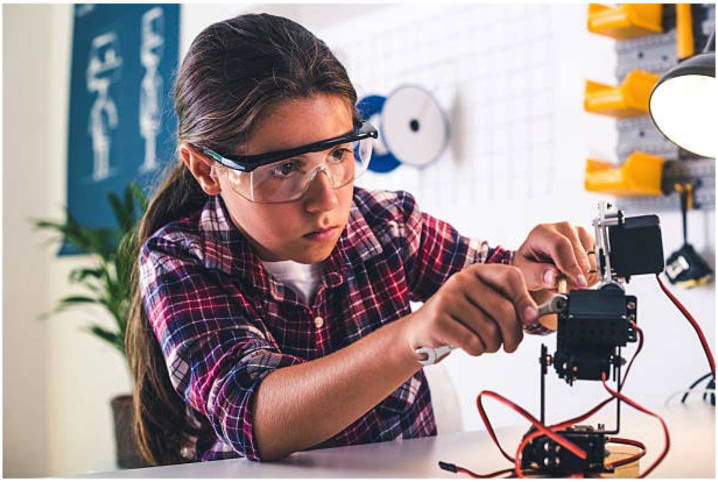

Figure 2.13: A young kid working on her project.

Source: https://www.istockphoto.com/photo/research-and-development-gm596348736-102221015?phrase=science%20%2C%20technology%20and%20innovation

Figure 2.14: Researchers broadcasting their results in a forum.

Source: https://www.istockphoto.com/photo/on-stage-successful-female-ceo-and-male-coo-speakers-present-companys-new-product-gm1226991418-361713710?phrase=science%20%2C%20technology%20and%20innovation

3. Financial assistance for the development of local public health service delivery capacity should be increased. A significant increase in the global supply of skilled health professionals is urgently required. Public health schools with training and research capabilities should serve as health infrastructure pillars. A significant social service component is an essential component of such skills (Liu & Zhang, 2011). It may be possible in some cases to modernize existing educational facilities (e.g., Uganda). In some cases, new institutions are required (e.g., India). In general, the American model may be advantageous to global development.

“3 Enhancing Developing Countries’ Science and Technology Capabilities,” National Science Foundation, 2006. Science and Technology’s Critical Role in International Development: An American Obligation International Development Agency

2.9 EAST AFRICAN LEADERSHIP IN PUBLIC HEALTH INITIATIVE

USAID proposes a partnership with a small number of African institutions for public health training with U.S. counterparts to strengthen the institutional capacity of the African school and provide advanced leadership training relevant to Africa's health needs, including epidemiology, health policy and planning, public administration, budgeting, human resource management, and field research.

The information was provided by USAID's Association Liaison Office for University Cooperation in Development in May 2005.

It is necessary to consider the specific needs and capacities of various nations when developing curricula and ancillary infrastructure for these educational institutions. USAID intends to apply this strategy throughout Africa. This program, as well as similar new initiatives in India and other countries, is long overdue as populations grow, diseases multiply, and public demand for better health care grows (Lieber, 2003).

4. Improve the acquisition, processing, and electronic access to major institutions' scientific collections in developing countries where USAID has programs. As developing countries continue to build their science and technology infrastructures, local educational and research institutions must improve their databases on development-related topics. This will avoid duplicating previous research and improve the environment for attracting talented students interested in conducting research. Furthermore, access to electronic scientific materials, which are sometimes only available through complex library systems, must be improved. The growth of broadband Internet infrastructure and the rise of specialized databases may provide developing-country experts with new ways to keep up with global S&T advancements in critical fields for a low investment. Access to digital libraries should be made more widely available on a global scale.

USAID should set up short-term assignments for American experts skilled in database management and the use of international databases in several of the countries where it runs programs. Increase local interest in utilizing global scientific resources and assist counterparts in developing cost-effective strategies for effectively utilizing these resources through this low-cost strategy(Liu & Ihl Woo, 2006).

Numerous informational resources, including textbooks and public libraries, must be modernized. Regardless of the report's recommendation, the suggested citation is "3 Strengthening Developing Countries' Science and Technology Capacity." 2006, National Research Council the United States Agency for International Development (USAID) must recognize the value of science and technology in international development.

Development of software in the field of information technology

Large single crystals, infrared detectors, and semiconductors are used in modern technology.

Two examples of this technology are lasers and light detection and ranging (Lidar systems)

- Electromechanical systems precision
- Agricultural products derived from processing
- A healthy diet includes dietary supplements and functional foods.
- Chemical and substance products aimed at specific markets
- Filtering with minerals
- Engineering in systematics
- Industrial applications of nuclear magnetic resonance
- Genomic research

The data is primarily sourced from the National Research Council. It was published in 2004 by the National Academies Press. Science and Technology Contribute to Armenia's Knowledge-Based Economy

Despite its emphasis on scientific information, it is likely to have unintended consequences that encourage the expansion of information services in other fields.

5. Professional assessments of S&T infrastructures in countries where the US has no presence should be funded. The US Agency for International Development manages significant programs. If teams of local and international experts are available, such analyses of the current and potential contributions of public and private S&T resources to development should be carried out. The evaluations are expected to provide critical information on how host governments, USAID, other donors, and international organizations can strengthen infrastructure and integrate science and technology resources into the mainstream of economic and social development (Kobayashi et al., 2019). In these assessments,

> economists and social scientists both have a lot to offer. However, if neither the host government nor the donor organizations express an interest in such assessments, it is probably best to postpone their implementation.

The target country will determine the scope of the assessment. A comprehensive assessment within the scope of a single project would be extremely difficult given Ukraine's extensive infrastructure. Although different S&T activities frequently complement each other and the potential for synergy is often overlooked, it may be possible to divide the evaluation into several components (e.g., the contributions to the nutrition of both health care and agriculture). Mali's infrastructure, on the other hand, is deficient. The suggested citation is "3 Strengthening Developing Countries' Science and Technology Capacity." 2006, National Research Council The United States Agency for International Development (USAID) must recognize the value of science and technology in international development.

An in-depth investigation by an expert team is warranted after the committee visits the country.

In contrast to other conclusions, which focused on trends in the development of technical manpower and the overall policy framework for science and technology, this particular conclusion focused on cutting-edge technologies with commercial promise. It was impossible to include local experts who were already committed to their S&T strategies, so an American team headed the effort (Howe-Walsh & Turnbull, 2016).

The findings should have piqued the interest of numerous organizations, given that the U.S. In particular USAID, the Armenian government, and the international scientific community, Ambassador in Yerevan requested the evaluation. USAID's program objectives benefited from some interdisciplinary research (e.g., the undeveloped and poorly enforced regulatory infrastructure for protecting intellectual property rights, the paucity of research at the universities, and approaches to countering the brain drain) (e.g., the undeveloped and poorly enforced regulatory infrastructure for protecting intellectual property rights, the paucity of research at the universities, and approaches to countering the brain drain). This is all we know about the situation at this point.

The assessment cost $165,000, a fraction of the $56 million annual USAID budget for Armenia at the time.

It should be possible to begin implementing the aforementioned initiatives within the framework of existing USAID programs without significant budgetary reallocations at this point. Initial efforts that have a significant impact may be expanded to improve local S&T capabilities if they are successful (Hagendijk & Irwin, 2006). Investments in science and technology will have to wait until host governments and private companies are convinced that it is profitable to do so.

The United States Agency for International Development (USAID) must recognize the value of science and technology in international development.

CHAPTER 3

COMMUNICATION AND TECHNOLOGY

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From smoke signals and messenger pigeons to the telephone and email, humans have created new ways to communicate. The electric telegraph was invented in 1831. Posts existed before the 19th century, but electrical engineering had a revolutionary impact. Digital communication has surpassed almost all other methods, especially in business. How far communication has come is simply amazing.

3.1 EMERGENT COMMUNICATION TECHNOLOGIES

3.1.1 Calling

The telephone was invented in 1849 and became a necessity in 50 years. Tethering limited flexibility and privacy. The phone appeared. Motorola's 1973 mobile phone sparked a series of communications innovations.

Early smartphones, which bridged phones and PDAs, were bulky and had short battery lives. Nokia started offering QWERTY phones in 1996, but most Android phones have touchscreens now (Granato et al., 2014).

Apple is credited with inventing the modern smartphone aesthetic with the 2007 release of the iPhone. Before the iPhone, flip phones and split-screen phones were widespread. A year later, a central app store with 500 "apps" was established. Apple's App Store contains 2 million applications.

3.1.2 Web-based

The Internet revolutionized communication in the 1990s. Examples include email, instant messaging, VoIP phone conversations, two-way interactive video chats, discussion forums, blogs, and social networking.

We may now converse swiftly and simply online, with anybody, wherever. It increased business speed and alternatives. YouTube, social media, and memes allow individuals to express themselves. Internet has united and divided us like never before.

3.1.3 Email

Email was used for years before the WWW made it publicly available in 1991. Email has either improved or worsened our lives, depending on your perspective. The military and education were the first to use email. In 2018, almost half the world's population utilized email. By 2022, 333 billion personal and business emails will be sent daily.

New tools are threatening email's supremacy, despite its indispensability. Slack stands for "Searchable Log of All Communication and Knowledge" Slack is an email killer. Even if Slack has 10 million daily users, email is still utilized. Slack's upgrades ensure users who rely heavily on email may still collaborate (Grupp & Mogee, 2004).

3.1.4 Bodytech

The first wearable device was a hands-free mobile headset released in 1999. City employees soon adopted it. Entrepreneurs might accept calls while traveling.

Figure 3.1: A meeting held via technology.

Source: https://www.istockphoto.com/photo/global-corporation-online-videoconference-in-meeting-room-with-diverse-people-gm1325899588-410772531?phrase=communication%20technology

Ten years ago, making a video call from something other than a phone was science fiction. Wearable technologies like smartwatches, audio sunglasses, and other gadgets make these functionalities commonplace.

Figure 3.2: People using touchpads.

Source: https://www.istockphoto.com/photo/ill-share-the-information-with-you-gm863497390-143258825?phrase=communication%20technology

3.1.5 Virtual Reality (VR)

Since 2016, VR has revolutionized communications. Even if participants are in different countries, VR's presence feature lets them communicate without the time and price of travel.

VR enhances communication. VR can record a conversation's nonverbal cues. Voice tone, hesitations, and head and hand gestures help interpret emotions and intents (Gandini, 2011). VR has no interruptions, so users can focus on what's happening. MeetinVR says VR meetings have a 25% longer attention span than video conferences.

Virtual reality improves learning and retention, according to research. 3D eliminates linguistic barriers and technical jargon.

3.1.6 5G

5G promises faster upload and download speeds, broader coverage, and more consistent connections. This improves communication. Instant communication will replace sluggish video calls. Our devices can send 21 Mbps on 4G. 5G is 100-1000x faster. A two-hour video may be downloaded in 3.6 seconds, compared to 6 minutes or 26 hours on 3G or 4G. 5G's implications will go beyond smartphones since millions of devices may be connected at once (Adamovich et al., 2017).

Future plans include 6G. Even if basic research is still being done and it is 15-20 years away, it's innovative. 6G will be the foundation of the connected paradise we foresee, increasing communication consistency and speed.

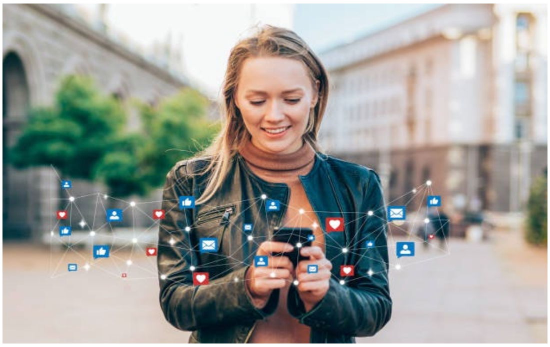

Figure 3.3: A person communicating via her phone.

Source: https://www.istockphoto.com/photo/staying-connected-gm1277665587-376815292?phrase=communication%20technology

Figure 3.4: An infographic on communication.

Source: https://www.istockphoto.com/vector/digital-marketing-concept-gm483171893-37599744?phrase=communication%20technology

3.2 NETWORK OPERATIONS AND MANAGEMENT

Network operations management

Modern network infrastructure is sophisticated, requiring close attention and maintenance around the clock. For this reason, an adaptable tool for effective network operations management is vital for a business since it proactively monitors and manages a network by providing complete visibility into network devices (Ferrari et al., 2015). It can also help technicians resolve alerts swiftly, enabling them to forestall network outages and prevent business performance disruptions.

4 key factors affecting network operations

- **Performance degradation:** Network bottlenecks and congestion due to a lag in performance can result in customer attrition and hefty damage to a brand’s reputation.
- **Lack of RCA:** Superficial visibility across the network can make technicians blind to minor, underlying glitches causing device failures and network downtime.
- **Absence of proactive alerts:** Alerting technicians only after network incidents occur, be it performance lag or any other issue, can increase the severity or even make the network experience downtime (Ferguson & Zhang, 2002).
- **Device malfunction:** Factors like a surge in temperature, an overloaded server, or high CPU usage affecting a parent device can also affect dependent devices and cause interruptions in network operations.

3.3 INTERNET AND IP BASED, ENVIRONMENTS AND SERVICES

1. Context Because of the fast growth of the Internet and other IP-based networks, network operators and manufacturers are reconsidering their services, network topologies, products, and so on. Information technology and IP-based networks and applications (such as E-Commerce) are critical to the growth of telecommunications networks. Data traffic is growing at a rate ten times that of voice traffic and will eventually account for 80 percent of all telecom network traffic.

Telephone networks that carry data will be overtaken by data networks that transmit speech as a result of this rapid transformation. Interoperability of IP-based networks and telecommunications networks, as well as interoperability of their applications/services, is critical to meeting the increasing economic demands on modern communications networks. Another advancement in telecommunications networks is the proliferation of mobile networks and higher user subscriptions. The ITU's IMT-2000 operates on 3rd generation mobile networks and has increased data speeds ranging from 384 kb/s to 2 Mb/s, as well as global roaming and a virtual home environment (enabling users to move seamlessly between fixed and mobile networks). Through global roaming, these capabilities will provide speedy, universal access to IP-based network services (Floros et al., 2010). The business orientations of telecommunications are changing. Standards bodies, forums, and consortia are confronted with new concerns of emphasis and direction.

ETSI TIPHON (Telecommunications and Internet Protocol Harmonization over Networks) and the IMTC Voice over IP Forum (VOIP) are two new organizations that are addressing comparable issues. We are dealing with massive changes in the telecommunications network, as well as shorter development intervals and product life cycles. To create standards more quickly, standards bodies must shift their focus and work direction. Interoperability between networks and applications is increasing. Interaction of IP-based networks and telecommunications networks to access the Internet or other IP network applications, as well as the need for IP-based service and telecommunication service interoperability, means providing real-time Internet or other IP-based multimedia services with the speed, capacity, ease of use, reliability, and integrity of public telephone networks around the world. ITU-T has made significant progress in numerous areas of telecommunications network standardization. - 2 - Although the ITU-T and the Internet Engineering Task Force (IETF) interact in various areas, we believe this cooperation should be reinforced in light of changes in ITU-T work emphasis and direction on IP-based networks. The ITU-T and the IETF will be critical (Foest et al., 2006).

The IETF specializes in protocol and application development, whereas the ITU-T specializes in architecture, network interworking, and network evolution. PP98 considered these concerns while passing Resolution COM 5/14. (IP-based networks). The PP98 Resolution takes into account: - that ITU-T studies on IP-based network issues, such as service interoperability with other telecommunication networks, numbering, signaling requirements, protocol aspects, security, and infrastructure component costs, have already begun; and - that general cooperation arrangements between ITU-T and the Internet Society (ISOC) and its Internet Engineering Task Force (IETF) have recently been established, encouraging ITU-T to cooperate. At the next WTSA in 2000, the ITU-T will examine its work priorities, direction, and organization. According to TSAG, IP-based technologies will be a critical component of network infrastructure by the year 2000. The ITU-T cannot wait until 2000 to change its work priorities in order to maintain its leadership role in defining global standards for network evolution.

- TSAG recommendation

During its meeting in September 1998, TSAG reached the following agreements: 1) Study Group 13 is in charge of intellectual property issues. 2) Guidelines for ISOC/IETF Study Group involvement, including notifying the IETF of ITU-T Study Group activities and receiving IETF activity information. 3) All ITU-T Study Groups should examine their Questions in order to offer IP-based network recommendations in their respective areas (Dhillon et al., 2017). TSAG has also resolved to issue a Liaison Statement to all Study Groups in order to encourage and clarify ITU-T and ISOC/IETF collaboration on standards development (IETF).

According to Council decision, ISOC is an ITU-T member. - Present situation: Study Group 13 has served as the primary Study Group on 'IP related aspects' since 1998, with the purpose of "providing a focal point in ITU-T for IP related research, including IP and telecommunication networks and their convergence." The Plenipotentiary Conference urged the Secretary-General in October 1998 to assess IP network-related ITU activities and identify areas where additional collaboration was required. In recognition of IP (Internet Protocol)-based networks and their effect on ITU members' short-term business perspectives, Study Group 13 established a "ITU-T IP Project" that is separate from but linked to GII research. As work progresses and ITU-T Study Groups enhance their IP-related activities, the project will be updated. Study Group 13 is preparing a September 1999 "IP Specialists meeting" during which other Study Groups' IP specialists will be requested to assist in its study.

In preparation for this conference, Study Group 13 sent a Liaison Statement to all ITU-T Study Groups, soliciting feedback on the ITU-T IP Project, particularly to help broaden definitions of work areas and projected deliverables. Descriptions of GII and IP projects may be found on the ITU-T website at http://www.itu.int/ITU-T/com13/index.html (see

Internet Protocol). Interactions between IP and telecom networks provide an interconnected network where people may communicate and share ideas(Doi, 2006). To make the vision a reality, the ITU-T must use its knowledge, experience, and skills to create global standards for communications networks. To meet corporate expectations, the IP project intends to overcome challenges connected to IP and telephony interoperability.

The Internet Protocol suite of the IETF is utilized. The ITU may provide value by collaborating closely with other important business and standards organizations, such as the IETF. The key priorities of ITU-12 T are mentioned below. 1 - Architecture integrated 2 - The impact of IP applications on telecom access infrastructures 4 - Interconnection of IP-based and switched-circuit networks, including wireless networks IP-based multimedia Areas of numbering and addressing; IP-signal transfer 7 - IP-based signaling, interconnection, and routing Integrated management of telecom and IP-based networks Concerns about security 11-Network features, such as resource management Area of Intellectual Property 12 OAM The project outlines the scope and emphasis, challenges, active ITU-T Study Group activities, and accompanying IETF work for each topic. Some of the content is unfinished and needs to be expanded(Cao et al., 2006). The IETF Working Group Charters, in particular, are being examined for overlap and places where the ITU-T may interact with the IETF. The project is described in full on the ITU-website T. A project outline is included in Annex 1.

According to WTSC-96 Resolution No. 2, Research Groups will continue to examine IP-related issues. Study Groups included IP-related questions at the request of TSAG. At its April 1999 meeting, TSAG considered the report of the main Study Group and liaisons from other ITU-T Study Groups. It will plan additional actions for WTSA-2000 in order to favorably respond to this Sector Strategic Plan priority. Annex 2 is a summary of the material given by Study Groups to Study Group 13 for the IP Project and in response to the request of TSAG.

The scope of the project is listed below. - 5 - Management - SG4 Naming, Numbering, Addressing, and Routing - SG2 Overall Network Architecture and Framework - Qs 25/13 and 29/13 IP and non-IP Access - Qs 12/13, 26/13, SGs 15 and 16 IP Transport - Qs 19/13, 20/13, and SG 15 IP Performance Workspace = 3-1-5-9-6-8-3-11-7-22-4 7 Operational Concerns 12 10 ITU-T IP Project Goals The IP project will be updated on a regular basis, with a focus on major deliverables from Study Groups in terms of approved or planned Recommendations. For IP-related suggestions, the Y. Series should be named "Global Information Infrastructure and Internet Protocol Aspects." For IP-related suggestions, the Y.100 through Y.9999 series will be utilized. Other Study Groups will utilize their IP-related series.

3.4 MOBILE AND WIRELESS CONNECTION

Mobile computing or nomadic computing has emerged as a result of tiny portable computers, wireless networks, and satellites. Mobile computing, also known as anytime/anywhere computing, has significant applications in business (for example, instant claim processing and e-commerce), telecommunications and personal communications, national defense (tracking troop movements), emergency and disaster management, real-time control systems, remote appliance operation, and Internet access. Mobile and wireless networking support that allows mobile users to interact with stationary users becomes critical in such contexts. There are several networks that can accommodate mobile users(Chadwick et al., 2011). A universal mobile device should select the optimum wireless network (LAN, Internet, PCS, or satellite) for the user's needs.

A mobile workforce is made possible via wireless and mobile networks. Cellular, GSM, and PCS subscribers worldwide increased from 140 million in 1996 to over 300 million in 1999 (Source: www.gsmdata.com). Capital expenditure went from $6.3 billion in 1990 to $66.8 billion in 1999, while service income increased from $4.5 billion to $38.7 billion (see www.wow-com.com) (b). The average local monthly cost fell from $80 to $39 throughout the same time period, suggesting technical maturity and severe competition (Borup et al., 2006). Several generalizations may be made about wireless systems. First, wireless channel capacity is lower than estimated by Upkar Varshney and Ron Vetter. Wired networks lack mobile and wireless networks due to limited spectrum, power constraints, and noise levels.

Despite breakthroughs in coding techniques, capacity is limited since users share it. Noise and interference have a greater impact on wireless system design than on cable systems. Third, the FCC must allot frequencies before constructing a wireless infrastructure. Fourth, because data flows in free space, wireless systems are less secure than cable systems (except for infrared LANs). Wireless interfaces are unnecessary for mobile people, and wireless does not promote mobility. Mobile users can connect to fixed networks through wired connections while on the go. A wireless interface may be used by a fixed-location user in an office (through LAN). Despite their similarities, mobile and wireless systems are distinct. Routing and location management are made possible by mobile networks. Wireless networks enable mobile and stationary users to allocate bandwidth and regulate errors.

When coupled, various challenges arise, such as optimal utilization of narrow bandwidth channels due to limited frequency allotment, management of massive bit-error rates due to high noise levels, application-level quality of service support, increased security concerns, and equipment failure or malfunction. The MAC address can have an influence on wireless network performance and utilization(Bell & Lederman, 2003). The cellular and PCS MAC protocols used in the United States and Europe differ. In the United States, FDMA (in AMPS), TDMA (in PCS), and CDMA (IS-95) are used, but GSM utilizes TDMA/FDMA on multiple frequencies.

This has an influence on cellular interoperability and global roaming. Corporations in North America are pushing for CDMA (or Wideband CDMA) to ensure backward compatibility with CDMA-based IS-95, whilst Europe favors TDMA for GSM compatibility. Some 3G system agreements let all of the aforementioned networks to interoperate with or evolve into 3G wireless networks (www.itu.org). New mobile/wireless networks Wireless local area networks (WLANs), satellite-based networks, wireless local loops (WLLs), and wireless ATM networks are also progressing.

Bluetooth radio communications allow low-cost, short-range connections for wireless computers, printers, and scanners. Because of its limited range, it may use unlicensed 2.4GHz ISM. WI-FI Wireless LANs supplement or completely replace conventional LANs in limited areas such as a building, corridor, park, or office complex (such as Ethernet). Wireless LANs provide mobility and flexibility; bandwidth is secondary. Unlike cellular networks, WLAN users must share frequencies. Collisions in frequency WLAN collisions are difficult to detect since signals to mobile users might have varied strength levels, and a station may miss a potential rival (the hidden station problem). The frequency is determined via microwave, spread spectrum, or infrared transmission. WLAN communication technology has an impact on interference and security. Infrared has limited coverage since it cannot travel through barriers (typically indoors). To reduce interference, it employs a broad frequency range. Encryption is used to provide security. Interference is likely since the ISM frequency is shared by other users and agencies. WiFi specifications AT&T's WaveLAN and Motorola's Altair were both proprietary wireless LANs. IEEE 802.11 and HIPERLAN have aided in the standardization of wireless LANs.

3.5 DEVICE-SPECIFIC INFORMATION EXISTING FREQUENCIES (REGULATED/UNREGULATED)

Higher frequencies Handovers Priority Handoff Affiliation TDM Access FDM A (FDMA) (TDMA) Retransmission of CDMA errors Correction of errors/retransmission Admission control Requests from current users obtain precedence Booking on the fly Adaptive error correction QOS-MAC Making use of unused channels Modifications to the Addressing/Routing Protocol to manage wireless loss After each move, the user updates his or her location (paging) .To handle mobility without changing existing apps, applications must adapt to QOS Wireless middleware.

3.5.1 Network for Comparing Signal Strength

The mobile device will compare base station signals and report to the current one. Keep track of user categorization. Sort applications Simple but not universal it's difficult yet useful. Interference in analog Slot speed and synchronization must be compatible. It is difficult to fulfill bandwidth requirements. Delayed (not used for real-time applications) Adaptive surplus bandwidth Processors (micro-cellular environment) Understanding cell/cluster traffic It is challenging to match user demand with network resources (Bernardes & e Albuquerque, 2003). Resources, complexity Amount of processing and impractical Location information are required for communications. The expense of updating New applications is required.

3.5.2 Heterogeneous Wireless Middleware

Processing requirements for mobile devices Limited-use Complex Expensive start Optional On 1Mbps ports, HIPERLAN offers 23.5Mbps channel speeds. Although 802.11 supports both spread spectrum and infrared, HIPERLAN only supports spread spectrum. 802.11, like HIPERLAN, prioritizes the media. 802.11 conserves energy for idle wifi users. IEEE 802.11-based LANs are promoted by many universities and companies for use with campus PCs and the Internet. By the year 2000, ETSI plans to standardize HIPERLAN2. This is intriguing since HIPERLAN2 employs different quality of service connections for apps. It will most likely operate in the unlicensed 5GHz spectrum across the United States, Asia, and Europe, time-diverging unicast, multicast, and broadcast connections.

To supplement ETSI standards, the HIPERLAN2 Global Forum (www. Hiperlan2.com) was founded by key wireless LAN operators. To compete with HIPERLAN2, IEEE 802.11 will offer 11Mbps. WLAN The local carriers own the local loop. Long-distance companies in the United States pay access fees for each long-distance or international call (Bøe et al., 2011). The Telecom Reform Act of 1996 attempted to address this, but because long-distance companies have not created local loops, they continue to pay access charges ($20 billion last year). Many developing countries suffer from a lack of infrastructure. Wireless Local Loop might be beneficial (WLL).

Long-distance carriers in the United States choose WLLs to avoid access costs. WLLs, unlike cellular and PCS, provide fixed wireless access, therefore they may provide several MHz of bandwidth for high-speed Internet and data transfer in addition to basic phone service. In underdeveloped countries where laying kilometers of copper is unfeasible, WLLs enable phone and low-speed data transport. Within a few kilometers, cellular and microcellular systems may be deployed in WLL contexts with 9.6Kbps for 10-100 users. WLL can be supported by wireless LANs in smaller regions with greater bandwidth requirements. Fixed wireless access systems, such as LMDS, may provide high bandwidth (tens of Mbps) in large areas for a large number of users, but they require line of sight.

LMDS is a new technology developed by point76. 43/6/2000 ACM Local Communications 1-20Mbps Data/Voice Capacity Coverage that is beneficial Problem with application bandwidth Status Cellular/PCS Mobile IP/ATM WI-FI WLAN Satellites Metropolitan Voice/data bandwidth of 19.2Kbps ** WAN-reliant Various Data/Voice Apps 1–20Mbps Widespread Emergence Voice/Data Initial Cost: 19-2Kbps to a few Mbps Emerging Local/Metropolitan Conflict Emerging: 3-10 kilometers for LMDS, depending on technology. 1-20Mbps Voice/Data ** This is dependent on the wireless network. *** Teledesic satellites have a higher limit. (Alexander et al., 2006).

Orbit (height) Spacecraft (channels) Applications for Runtime Charges Date-to-multipoint applications. Several hundred operators in the United States have just been allocated 1.3GHz of spectrum by the FCC. LMDS employs a broad spectrum and allows for large two-way data rates. Several hundred megabits per second (Mbps) Internet, phone, and cable TV broadcasts are conceivable. Satellites Geosynchronous satellites offer broadcasting, long-distance and international phone service (to stationary customers), paging, and data networking. Advances in antenna design, signal reception, and other technologies have enabled mobile satellite services to become a reality. Several initiatives of this nature are currently underway.

3.5.3 Iridium

Iridium is a low-earth orbit (LEO) system that employs 66 satellites to deliver mobile communications worldwide. Since wireless customers have diverse needs—some may need worldwide roaming, while others may merely wish to complement their cellular coverage in underserved areas—designed it's to provide multiple goods and services. In Iridium, a user's call may be transferred to another satellite. Concentric spacecraft maintain links with up to four adjacent satellites. Handoffs are required for counter-rotating satellites to maintain cross-links. Iridium service began in January 1999, however, due to technical difficulties and excessive pricing, the number of customers was substantially fewer than required to sustain this multibillion-dollar network, which has been declared bankrupt and has ceased commercial operations (Badgujar et al., 2008).

Other prospective LEO-based networks must enhance their marketing and decrease upfront and per-minute costs to avoid a similar fate. The scale of the market for such services is difficult to define, although satellite phone service is popular in places lacking cellular connectivity or with severe call blocking. Microsoft and McCaw Cellular's $9 billion Teledesic project is another LEO-based network. The project's original goal of deploying 840 LEO satellites has been reduced to 288. Boeing is a significant investor and prime contractor. In 1998, worldwide licenses for 29GHz uplink and 19GHz downlink were issued. This is the first time a satellite system will allow "fiber-like" communication with the Earth and other satellites. The majority of Teledesic terminals operate at 64Mbps downlink and 2Mbps uplink. (www.teledesic.com).

W-ATM (Asynchronous Transfer Mode). orATM is a high-speed networking system that sends data in 53-byte packets (referred to as cells) that may be created, transported, and switched very fast.

An ATM cell's 53 bytes are made up of 5 overhead bytes and 48 data bytes. ATM can handle both real-time and non-real-time communications with varying latency, loss, and throughput requirements. ATMs can be used at high data rates in both local and wide-area contexts because they are scalable. The motivation for wireless ATMs. Wireless ATM is a possible new technology in which ATM cells are transferred via wireless channels and a portion of the ATM connection is wireless. ATMs were implemented in wireless for smooth interaction with backbone ATM networks, QoS support for wireless and mobile users, and the appropriateness of tiny packets over wireless channels. ATMs were not designed to operate over varying channel characteristics, so their introduction into wireless environments presents numerous challenges (Banerjee & Williams, 2013). Maintaining the end-to-end ATM connection when the user moves, implementing quality-of-service support, and dealing with wireless connectivity to enable mobile computing applications are among the issues. Final guidelines will be released soon by the ATM Forum, a global coalition of ATM firms.

As a result, commercial deployment might be just a few years away. Impediments include a lack of standards, expenditure, complexity, and overhead. Increased radio bandwidth allocation, emerging reliable and QOS-oriented protocols, and wireless ATM error-control protocols will aid in the deployment of mobile wireless ATMs. Third-generation wireless networks are also being considered. When a mobile user relocates, the ATM's connection must be redirected. (a) Establishing a new connection, (b) providing several paths to a mobile user, (c) forwarding ATM cells, or (d) dynamically rerouting the connection. Mobile host locations are required by the wireless ATM network to route or redirect ATM connections. Any changes in location should be reflected in the storage system, which is usually a database. When connecting to a mobile host, the network should have the new location information. When using wireless connections, ATM cell loss is significant. Employ forwarding error-correction algorithms or an error-detection approach (Cyclic Redundancy Control) followed by buffering and selective retransmission of ATM cells to prevent cell loss. Retransmission and resequencing need ATM sequence codes. A 53-byte ATM cell, a sequence number, and error-control overhead may all fit in a larger WATM cell. Middleware/Apps Mobile middleware is a software layer used by app developers to connect their programs to mobile networks and operating systems without introducing mobility (Zhang et al., 2018). Middleware can improve application response times and dependability. To reduce wireless network traffic, middleware uses header compression, delayed acknowledgments, and packet concatenation. Middleware increases complexity and costs (10–300K is a range for most wireless and mobile middleware).

Express (www.nettechRF.com) is mobile messaging middleware that enables non-IP applications to be delivered to mobile users. It saves and sends communications when a mobile user is out of network range. Many wireless access technologies are incompatible with one another. Developers would struggle to create network and commercial apps for each technology. This problem is exacerbated by the redesign of all websites to facilitate mobile downloading. Even after all of this, information content must still be transformed for wireless network transmission. This allows for the development of applications that are not dependent on the underlying wireless access technology. WAP modifies website content for wireless transfer and mobile viewing. WAP specifications were developed by the WAP Forum (www.wapforum.org), a partnership of wireless companies.

The primary contribution is the interoperability of wireless networks, devices, and applications using a common set of protocols. Wireless is employed, which is similar to the protocol architecture of the Web. A gateway acts as a proxy server for a mobile client, transforming requests from WAP protocol stacks to information server protocol stacks. Encoders compress server data to reduce the amount of wireless transmission (Zeldin et al., 2008). This infrastructure ensures that mobile users may access a wide range of information and applications, and it allows developers to create content services and apps for a large number of mobile terminals.

3.6 MOBILE OPERATING SYSTEM

A general-purpose operating system is not ideal for small portable devices due to real-time needs, lower processing power, memory, and screen size, as well as speech applications. A small operating system is required to enable computing-related operations on digital wireless devices. The sizes of mobile operating systems range from 300KB (Palm OS) to 2MB (Windows CE). The GEOS 3.0 on the Nokia 9000 Communicator is 300KB. Many of these operating systems have attracted developers to create portable apps.

Figure 3.5: A phone connected to the internet.

Source: https://www.istockphoto.com/photo/connect-to-wifi-wireless-internet-network-with-smartphone-at-coffee-shop-or-hotel-gm1146115827-308728502?phrase=mobile%20and%20wireless%20

3.7 TELECOMMUNICATION SERVICES DESIGN AND QOS

Quality of Service (QoS) refers to network traffic performance. ITU-T defines QoS as “the combined effect of service performance determining user satisfaction.”

Other QoS notions include:

- Service performance
- Operational performance
- Severability and
- Service security

Telecommunication operators and service providers can improve QoS, retain more consumers, and gain from rival operator attrition. Operators balance QoS and cost (Wu et al., 2019).

3.8 CLASSIFICATION OF SERVICE

People new to telecommunications sometimes mistake QoS and SLA (GOS). E.600 ITU-T defines GOS. According to ITU-T, GOS measures the sufficiency of a collection of resources under specific conditions.

Four critical aspects of a 1-node GOS.

3.8.1 Blocking Probability

Blocking probability is the most typical GOS and happens in a telephone network with no buffer for traffic congestion. Refer to Erlang-B Formula for the notation of blocking probability, which is B. Loss-call is determined using the Erlang-B formula in a Poisson-distributed network. Loss-call is determined using the normal-loss algorithm in a Gaussian traffic network (Woolgar & Lezaun, 2013).

Blocking probability end-to-end.

End-to-end network performance is planned using NNGOS. Assume each route’s blocking probability is pi, its carrying probability is qi = (1-pi), and its end-to-end blocking probability is Pete. The formula for end-to-end serial link blockage probability: iete pp (1)

3.8.2 Propagation Delay

Propagation delay is the time a packet takes to transmit. Increases with transmission distance. For radio communications, wave velocity approaches the speed of light, hence packets encounter a 3.33-microsecond propagation delay at 1 kilometer. In communication lines at 0.6 to 0.8 the speed of light, a packet's propagation latency is 4.5 microseconds every 1 kilometer (Wang, 2009).

3.8.3 Jitter

End-to-end GOS jitter is significant. There's time jitter and frequency jitter. a. Jitter. Time Jitter in telecommunications is unwanted end-to-end delay deviations. End-to-end latency causes time jitter. First, generate end-to-end delay curves as a function of time, then seek for a maximum or minimum peak value, then determine the period between the two peak values. Time jitter is twice this period. Time jitter degrades real-time connections like VoIP. Intermittent conversation. b. Jitter. Time Jitter is the inverse of frequency jitter. EMI and crosstalk can induce frequency jitter. Frequency Jitter can degrade processor performance and cause packet loss.

3.8.4 Packet loss

Packet loss computation is difficult if the buffer size isn't infinite. If buffers were unlimited, packet loss would be impossible. Packet loss calculation should consider packet arrival distribution, server service distribution, buffer capacity, and queuing disciplines. In this book, packet loss isn't calculated.

3.8.5 ITaU-T PSGOS Parameter

In ITU-T recommendation E.726 series equivalent to E.721, GO standards for call level are not the same as packet-level GOS.

Packet-level GOS parameters include:

- PTP delay
- Variable packet delay
- Erroneous packet block ratio
- Packet loss ratio
- Frame transmission delay
- Frame discard ratio

3.9 GENERAL CONCEPT OF QOS

ITU-T Rec. E.800 provides a set of commonly used terms in the study and management of quality of service (QoS) (QoS). The technical and non-technical terms related to the QoS are listed and intended to represent the interests of all parties of telecommunications service market, i.e., user, service provider, manufacturer, and regulator. Based on ITU-T Recommendation E.800, quality & performance in the the telecommunications field can be divided into several levels as follows: NP: network element performance (Wynne, 2007). NP is determined by evaluating numerous technical criteria that define a network element's performance against a standard. NP

Example:

BER, TD, PT, jitter. All network elements' performance is merged to produce a "black box" that measures performance. For example, UNI (User Network Interfaces). End-to-end QoS: total performance of elements and processes in a telecommunications service's transmission chain. QoS is assessed from the user's perspective but not objectively. QoS metrics depend on service features. QoE: total performance of a telecommunications service measured by users. QoE evaluation is subjective due of user experience and expectations. QoS models ITU-T Recommendation G.1000 describes QoS from four aspects. Figure 4 illustrates four QoS perspectives. This is explained later. Clause 2 gives a generic definition of QoS based on quality. QoS perceived by the user is of special relevance. QoS is affected by delivered QoS and user perception. Understanding QoS helps service providers maximize revenue and resources (Woellert et al., 2011).

ITU-T describes four QoS Model angles: QoSR (QoS required by the User). Customers' QoS demands are articulated in non-technical terms.

QoS reflect telecom service providers' QoS achievements. QoS tests a provider's ability to deliver promised QoS. SoE (QoS Experienced by the User). Users' QoS represent their subjective perspective in specific situations. Customer pleasure drives this QoS. QoSE is defined in nontechnical parameters.

Customers can be surveyed to measure QoSE. At this level, a user mixes personal experience with service excellence. Other things impact QoSE than technology. Some of these aspects include the user and service provider's contract, the service provider's capacity to address customer complaints, and the general customer-provider relationship (Whitcombe et al., 2014). Thus, QoSE is hard to assess since there are many "hidden" elements. Practical User QoS versus Operational Performance.

3.9.1 Why Do QoSE Measures Differ?

(QoS Experience by the user) and QoS (QoS Delivered by the provider), while QoS and network performance don't conflict?

Many elements affect a customer's impression of a provider's QoS service. Customers compare the service they receive to what they expect. Rates and media/book information impact customer expectations. If a consumer feels pricey, their service quality standards are high. KPI provider of owned or rented telecommunications equipment (Key Performance Indicator). With higher KPI and more realistic service rates, consumer expectations for QoS telecoms performance will rise.

Figure 3.6: A telecommunication engineer at work.

Source: https://www.istockphoto.com/photo/electrician-gm522540308-91679013?phrase=telecommunication%20services

Good customer service helps a supplier understand client expectations. Customer service should comprehend operational performance measured by KPIs and the link between customer complaints and KPIs. Customer service is bidirectional. One, they should be able to respond to client concerns according to technological conditions. They should also be able to steer the organization, translating consumer demands into technical performance standards. Lesser providers neglect customer service (Verbeek et al., 2002). Customer frustration will occur. Customers were upset since their complaints weren't addressed properly. Provider engineers were unhappy since the gadget was already operating according to technical requirements, but the firm read so many reports of consumer displeasure.

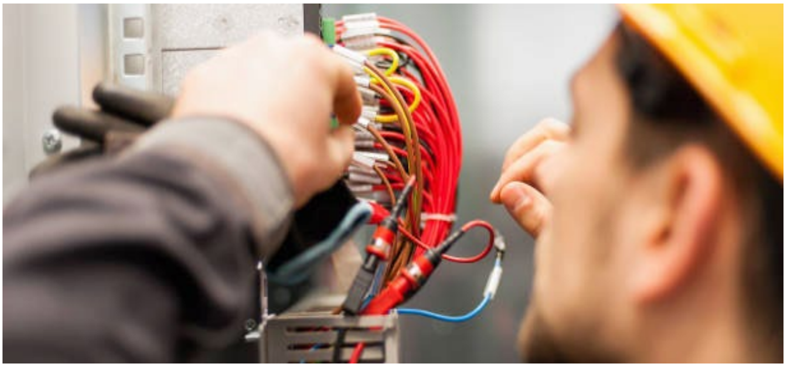

Figure 3.7: Network cables being connected.

Source: https://www.istockphoto.com/photo/electrician-engineer-tests-electrical-installations-on-relay-protection-system-gm910235118-250683666?phrase=telecommunication%20services

3.10 OPTICAL AND PHOTONIC COMMUNICATIONS

A photonic network transmits information optically, not electronically. It transmits data using light, not electricity.

In a true optical network, every router, switch, and repeater would use light; packet origin and destination would convert to and from electrical impulses.

Commercial networks combine electrical and optical networking. Multiple light-to-electronic and electronic-to-light conversions occur. Light signals travel long links and high-capacity connections in data centers, campuses and building backbones, but are transformed into electrical signals in routers and network equipment(Terrones, 2003).

Why opto-net?

Optical networks are fast, long-range, and large.

Optical networking lowers latency. Where electric current transports data at 10% of the speed of light, 18600 miles per second or 30,000 km per second, optical signals in fiber optic cable travel at the speed of light, 186,000 miles per second or 300,000 km per second.

Using electronics and copper, speeds peak out at 100 Gbps over short distances. Optical networks can transfer more data over longer distances. Fiber can carry 100 Gbps over a single data channel and over kilometers with amplification. Dividing a single optical connection into numerous data channels increases speeds.

A single strand of fiber-optic cable may transport optical communications on numerous wavelengths concurrently since light beams don't interfere. This is WDM. WDM networks can pack a single cable with two to 160 channels, with peak capacities above 10 terabits per second (Tbps).

3.10.1 Flexible Optical Networking

Dynamic provisioning allows network managers to quickly increase the capacity of their optical network by lighting up new optical channels on an existing fiber. Users can get more bandwidth in days — even hours — rather than weeks or months(Sismondo, 2018).

Free space optics (FSO) transmits data using lasers without optical wires. FSO can provide high-throughput wireless communication with minimum lead time, despite its lesser capacity than fiber-optic networking and susceptibility to precipitation interference. FSO can transport data over larger distances than Wi-Fi for less money than pulling fiber.

3.10.2 Security Optics

Copper cables are easier to tap and read than fiber optic lines. Government and defense establishments utilize optical networks extensively, occasionally linking them to desktops. Quantum networking prevents intruders from tapping optical transmissions unnoticed.

Who utilizes fiber optics?

Everyone, or every organization kind and size.

Performance, capacity, agility, and security make optical fiber a popular choice for campus and building network backbones, where bandwidth needs are high and electromagnetic interference from other building services, such as high-voltage power cables, is high.

Last-mile fiber connectivity is also growing in popularity. Fiber conveniently allows dynamic bandwidth services, allowing service providers to give a gateway for clients to evaluate their bandwidth needs.

Figure 3.8: An infographic on optics.

Source: *https://www.istockphoto.com/vector/optical-health-icons-monoline-series-gm1330603342-413973450?phrase=optical%20*

3.11 THE COMMUNICATION BETWEEN ROBOTS AND HUMANS

Modern social robots interact with humans by using analog sensors that are transformed into digital data for programming.

We may split their interactive tools into artificial senses and externally observable reactions, with the latter mediated by artificial intelligence, the result of all protocols meant to interpret and respond to received data and stored memories(Shannon et al., 2010).

After reviewing them, we'll examine five strategic ways social robots can connect with humans.

Artificial senses

Like animals, robots require artificial senses to detect their physical environment.

Social robots like Pepper can see, hear, and touch, but not taste or smell.

Why can't robots smell or taste?

Although sophisticated drug-detection apparatus used by customs officers to stop illicit trafficking activities may be supplied with an "artificial nose," there is no obvious economic basis for equipping a social robot with such pricey technology to detect chemical vapors in the air.

Taste is another animal sense that depends on the detection of chemicals, usually in the presence of a water-based fluid called saliva that breaks down food and releases its chemical constituents (Suryanarayana et al., 2001). Because water is electrically conductive, it would be electrically unsafe for an electronic machine with moving parts like a robot to have any kind of fluid inserted into it to imitate this process.

3.11.1. AI

Robots use inbuilt digital cameras to capture visual surroundings. This gives their programs a rich stream of data to recognize these surroundings, the first stage in responding correctly to enhance conversation with adjacent individuals.

3.11.2. Implants

Social robots have built-in microphones to receive analog audio data. Analogue-to-Digital Converters (ADCs) transform this into digital audio for their programs. To understand digital data, they must be designed to interpret ADSR (attack, decay, sustain, release) envelopes and frequencies. They should be taught to distinguish words from digital audio patterns of human speech and understand surrounding sounds so they're not distracted while humans speak.

3.11.3. Artificial Touch

Advanced robots can have an outer ‘skin’ created responsive to pressure and/or electrical conductivity, replicating how humans experience touch and forces.

Touch sensitivity can help social robots communicate with humans. It can identify when a person touches them, allowing programmed social reactions. It can also help them identify the weight of an object they’re meant to carry and defend themselves if struck (Antal & Grønli, 2003).

When robots like Pepper have an inbuilt tablet, they employ touch-sensitive screens to access their programs.

Robots like Pepper use inertial sensors like gyroscopes and accelerometers to monitor their moving components and joints. These sensors are usually utilized programmatically to avoid malfunction or falling over.

3.12 PERCEPTIBLE RESPONSES

The social robot programmer must first develop methods for interpreting the robot’s visual, aural, and tactile data. Second, create procedures to decide how the robot should respond depending on what its program knows is happening.

To give a social robot a semblance of intelligence, program it to respond to humans’ actions, needs, and intentions (Swierstra & Rip, 2007).

Depending on its design, the robot may be able to move in various ways and emit fake speech through its loudspeakers. Both sorts of capabilities may be used to make the robot interactive.

3.12.1 Mechanical and Electrical Motion

Social robots can be designed to use their electrical power to move their internal joints and walk. Some robots may be programmed to open doors or toss things, and others can run or jump utilizing leg-like appendages.

Robots can be programmed to rotate or wander. They can spin and bend their heads, move their arms, wrists, and fingers, and gesture. Even dancing. Modern social robots have these qualities, but they must be trained to act appropriately.

Internal lights and displays on robots can be programmed to turn on or off or change color to express emotion. Many social robots have electronic image-based 'eyes' whose appearance may be changed based on what they observe and its 'emotional' influence on them(Small, & Klavans, 2014). Since no mechanical motion is involved, all these appearance changes are electrical.

3.12.2 Speech, Sound

Almost all recent social robots include internal loudspeakers and virtual voice synthesis software to converse comprehensibly with humans. Social robots that vocalize like dogs and other animals are notable outliers.

Most social robots can emit audible tones and sounds that don't mimic speech to express their 'moods' or seek human attention. Some social robots play music and prerecorded sounds.

3.13 HUMAN-ROBOT INTERACTION

Having examined the technological principles of how robots might be equipped to communicate with people, we need also evaluate what forms of interaction humans like most. Here are five design and programmed behavior aspects that affect user impressions.

3.13.1 Robot Body and Head Design

People are happiest interacting with social robots that have human-like conduct and personality but don't look like humans.

We're saturated with apocalyptic science fiction shows about machines in human disguise taking over. Popular fiction and movies play on worries of humanoid robots.

Hanson Robotics is an active firm that has defied this common thinking and set out to develop robots that seem as human as possible, at least in their heads and faces, and has fashioned several of them after actual people. These robots are primarily employed on stage to answer questions (Rogers & Marres, 2000). People may be more comfortable observing them from a safe distance during a theatrical presentation than connecting with them closely in a private environment.

Softbank Robotics follows traditional thinking to make its humanoid robots look human. Pepper, the company's robot, has neither masculine nor female features.

Other robots may be non-humanoid. Some resemble dogs or eggs and are supposed to be adorable or childish.

The physical shape should consider the robot's mechanical functionality and aesthetic appeal. A robot must be visually beautiful to be socially accepted, unlike an industrial robot arm. To be labeled a robot, most people expect it to move.

3.13.2 Movement

Social robots will always move mechanically in response to an electrical current, but modern technology allows for motions that seem natural or elegant.

A fluid and responsive social robot can be more attractive to people than one that moves at a set and predictable speed (Rao & Cheetham, 2001).

A robot's actions shouldn't be too erratic or make people anxious, but they should be varied enough to provide the illusion of social awareness and inner consciousness.

3.13.3 Voice

How a sociable robot should sound is equally debatable. Should it sound robotic or natural?

Non-robotic interactive gadgets like Amazon's Echo compensate for their lack of humanoid or animal-like appearance and mechanical operation by giving them a genuine human voice. This is also a possibility for robots, but are consumers ready to hear robots speaking exactly like humans in their homes? (Porada et al., 2013).

Pepper has a robotic, child-like voice so it can't be mistaken for a person. Pepper's range of vocal pitch and expression is rather broad compared to traditional monotone robotic voices like the Daleks in 'Doctor Who?' or the robot in Exile for the BBC Micro (1988) that chases the player while firing bullets and growling, "'Pare to die!'"

Perhaps the need to get away from preconceptions of aggressive armed robots makes it more appealing not to give social robots repetitive voices.

3.13.4 Visual Interaction

Social robots with eyes should be trained to engage others without making them uncomfortable.

Social robots can sense movement, discern faces from inanimate things, interpret facial expressions, and follow people. They should be designed to shift their sight so they don't stare at one person for lengthy durations, which is disrespectful and uncomfortable in human company.

They may be trained to respond to unexpected and surprising motions with protective postures or terrified facial expressions.

When a human approaches a robot in a non-aggressive manner, it may be programmed to adapt its behavior by focusing closer attention on that individual and possibly even moving its arms into a position of readiness to gently embrace or have its hand held, provided the robot's design is robust enough to withstand this and safeguards have been built against pinched or trapped human fingers (Pahlavan & Makela, 2002).

Programming can identify and mimic human actions including dances, postures, and gestures.

Figure 3.9: A pic showing a person and robot touching.

Source: https://www.istockphoto.com/photo/ai-machine-learning-hands-of-robot-and-human-touching-on-big-data-network-connection-gm1206796363-348181260?phrase=robots%20and%20humans

3.13.5 Sonic Environment Interactivity

Social robots respond to indications that allow them to initiate a conversation, notably a greeting. Programming that identifies language and programming that infers from the speaker's head and eyes can manage this.

Social robots can be programmed to recognize vocal expression and not just language content to read the mood of their interlocutors. They can be made to respond adaptively to such cues by varying their behavior to mirror or complement the manifest mood of the humans with them – whether this is cheerful and jolly, nervous and animated, somber and morose, or calm and serious (Otsuka & Kakeshita, 2002).

Programming would integrate English understanding with non-verbal emotional indicators to choose the best response.

Figure 3.10: Person working with a robot.

Source: https://www.istockphoto.com/photo/mechanized-industry-robot-and-human-worker-working-together-in-future-factory-gm1320626664-407123312?phrase=robots%20and%20humans

CHAPTER 4

SPACE SCIENCE AND TECHNOLOGY

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4.1 INTERNATIONAL COOPERATION IN SPACE EXPLORATION

Space science has grown over the years such that it has come to a new level such that international cooperation has become the new norm in space exploration. The ideology of international cooperation seems like a new concept, it is not a new concept. It has been there as early as the 1900s. For instance, the National Aeronautics and Space Act stated that efforts will be made to adopt or incorporate the international community. This was after it created NASA in 1958. Currently, there is an unprecedented level of international cooperation with regard to the peaceful uses of outer space. There are various examples of international cooperation in space exploration like the International Space Station. The station was launched in 1998 and has been a good illustration of international cooperation can be useful in making tremendous achievements with regard to space exploration (Nisbet et al., 2002). Ever since the station was launched, it has made so many tremendous efforts by bringing many benefits to humanity. There are various elements of the station all of which can be well explained by the international partnership of space agencies that provides and operates the elements of the ISS. Some of the space agencies involved include the space agencies of the United States, Canada, Japan, Russia and other participating countries of the European Space Agency.

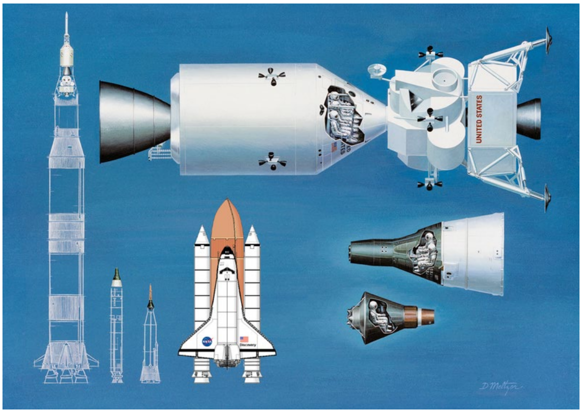

Figure 4.1: International cooperation will boost achievements made in space exploration.

Source: By NASA spacecraft comparison.jpg: NASA/Davis Paul Meltzerderivative work: Soerfm - This file was derived from: NASA spacecraft comparison.jpg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=26869916

There are various levels of international cooperation. The Artemis Accords has been very useful as it has contributed to another advanced level of international cooperation. It has contributed to the peaceful exploration of outer space. Artemis was introduced in October 2020. It has been useful in establishing a set of principles to guide space cooperation among different countries that take part in NASA's Artemis program. This further led to NASA landing the first person of color on the moon and the first woman landing on the moon. Artemis Accords has been very useful in creating a transparent and safe environment that facilitates exploration, science and commercial activities that can be enjoyed by all humanity. Different countries walk closely with the United Nations Office for Outer Space Affairs alongside the wider international space community through the UN Committee on the Peaceful Uses of Outer Space (Moore, 2013). The relevant growth of international cooperation with regard to space exploration can be attributed to the inputs made by Subcommittees such as UNOOSA and COPUOS. They all have had a hand in supporting the peaceful uses of outer space for all.

International cooperation has been present in various countries and in various forms. A good example is that in December 2020, both the UNOOSA and NASA signed a historic memorandum of understanding. This is very useful in enhancing and expanding the longstanding relationship between the United Nations and United States in outer space affairs. There is still more room to grow. This is well illustrated by the United States looking forward to working with the international partners to strengthen peaceful international space cooperation to increase its benefits to mankind. As international cooperation is very key to useful space exploration, there is hope that it will to greater heights. This brings about the topic of the future of international cooperation in space cooperation. This can be attributed to the fact that space since time immemorial has been an area of collaboration for countries despite the conflicts on the ground.

The noted trends in international collaboration in the past decade suggest that the nature of cooperation in space is changing. These changes have been highlighted by the fallout from Russia's invasion of Ukraine. With matters of space exploration, it is important to note that there is power distribution in space among countries, there are main players having different capabilities and have various options with regard to who they choose to collaborate with. There are scholars in the field of space exploration who predict that there may be a future in which single states will pursue different levels of dominance while others have a different perception in that they predict that commercial entities will come together there by bringing nations together (MacIá, 2005). The future may not be as predicted. However, there is a notable trend of different groups of nations having the same interests coming together to work on their interest with regard to space. This has led to the formation of the space blocs.

Figure 4.2: International cooperation has championed the adoption of space blocs.

Source: https://www.shutterstock.com/image-illustration/pixelated-earth-3d-blocks-planet-digital-1469752286

The future of space exploration may involve a shift from state-led space efforts to collaboration among countries. During the cold war, all activities with regard to space were majorly dominated by the Soviet Union and the U.S. There was great tension on the ground. However, they still remained on the same page as they were too careful to avoid causing crises. This led to a number of projects in space. This was during the time that various countries were opening their eyes and realizing that they can take part in space exploration. This led to a number of countries developing their own space agencies and international collaborative groups emerged. Some of the agencies that were developed include the United Nations Office for Outer Space Affairs, the Consultative Committee for Space Data System and the United Nations Committee on the Peaceful Uses of Outer Space (Martin, 2010). For instance, in 1975 about 10 European nations came together and founded the European Space Agency while in the U.S and Russia came together to build the International Space Station that was then supported by 15 countries.

The other trend in international cooperation includes the emergence of space blocs. Currently, the European Space Agency has a total of 22 nations and is considered among the first space blocs. It was anticipated that after the cold war more countries would shift towards the space blocs' type of power structure. This was well demonstrated by all countries with the same interests coming together to work and achieve specific mission objectives in space resulting in the formation of space blocs. The last few years have seen the emergence of new space blocks with various levels of space capabilities. A good example is the African Space Agency that has 55 member states. Others include the Latin American and Caribbean Space Agency having seven member states and the Arab Space Coordination Group with 12 members. These groups are very useful, in that they facilitate the coming together of nations with others who are in their blocs. Another added advantage is that the blocs are able to compete with each other allowing humanity to benefit from the competition. Currently, there are two recent space blocs namely the Sino-Russian Lunar agreement and the Artemis Accords and are known to compete with each other with regard to space exploration.

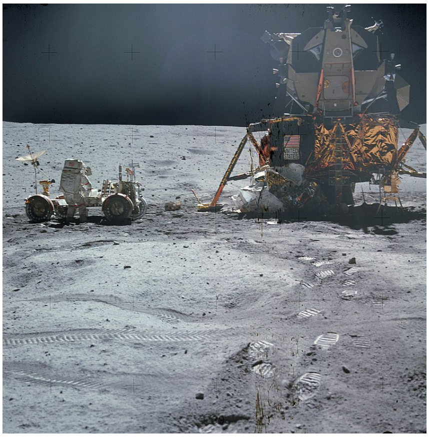

Figure 4.3: It is expected that more countries will join space exploration projects.

Source: Public Domain, https://commons.wikimedia.org/w/index.php?curid=525451

It is also anticipated that with the growing adoption of international cooperation among countries with regard to space exploration, there will be a race to the moon. This was noted after the Artemis Accords were launched in October 2020. The group consists of 18 countries and is led by the United

States. Their objective is to return people to the moon come 2025. They also want to establish a governing framework that will allow the exploration and mining of minerals or valuable metals on Mars and the moon among other areas. With this goal in mind, the mission aims at building a research station on the south pole of the Moon with a lunar space station (Liu & Zhang, 2011). Their space station is called the Gateway. In the same manner, China and Russia in 2019 came together and collaborate on a mission that will see people being sent to the south pole of the moon by 2026. Their union is known as the joint Sino-Russian mission. They also have the aim of building a Moon base and a space station in the lunar orbit.

The challenge however is that both blocs do not collaborate to accomplish similar missions on the moon. This means that some rivalries that exist on the ground between the two groups that have been transposed to space. In as much as several countries are being encouraged to join various agencies with regard to space exploration, it is important to know that it is not any nation that can join the Artemis Accords. This is demonstrated by the existing union between Russia and China who have joined forces with other countries to expand the dominated international order to outer space. China and Russia are in talks to open their own lunar research station open to all interested parties. However, none of the Artemis countries have expressed their interest in the China and Russia alliance. The alliance between Russia and China has faced a number of setbacks including the fact that the European Space Agency later on came to discontinue a number of joint projects with Russia as it has opted to work with the United States and Japan.

Figure 4.4: Russia and China are among the countries that have formed their own alliance with regard to space exploration.

Source: https://www.shutterstock.com/image-illustration/grunge-china-russia-flag-graphic-707059162

With the growing number of space blocks, it has its own effect on the ground. With regards to matters on the ground, many countries are seeking to establish their hold on the ground by demonstrating their power. This is also reflected in space as a number of countries have been noted to seek power in space. This has led to countries using space blocks to strengthen their spheres of influence on the ground. For example, in 2005 the Asia-Pacific Space Cooperation Organization was formed. Turkey, Thailand, Peru, China, Iran, Mongolia and Bangladesh are its member countries. The organization is led by china. The organization has a number of objectives including the launching and developing of satellites while expanding and normalizing the use of the Chinese BeiDou navigation system (Lieber, 2003). The Chinese BeiDou is the Chinese Version of GPS. It is worth noting that countries that will make use of such a system will become greatly dependent on China as noted with Iran.

With the growing adoption of international cooperation, the role of private space companies has become more established. This can be linked to the fact that there has been a notable growth in commercial activities in space over the last decade. This has led scholars to believe that the future of space cooperation may be defined by the shared commercial interests. In such a situation, the involved commercial entities will play the role of intermediaries between states as their role involves them uniting countries for certain commercial space projects. It is also anticipated that commercial enterprises may dictate the future of the international cooperation space. Currently, the international space law allows any company that operates in space is allowed to operate as an extension of its home's national government. This means that it works under the jurisdiction of its home's national government. The occurrence of the Ukraine crisis has exemplified the dominance of states over companies in space affairs. A number of commercial space companies have stopped their collaboration with Russia as a result of the state-imposed sanctions. The currently existing legal framework is such that states rather than commercial entities will be dictating the rules in space.

Figure 4.5: Private companies are more likely to encourage states to join space exploration agencies.

Source: https://www.shutterstock.com/search/spacex

This leads to the question of whether space blocks will bring collaboration or conflict. Many scholars believe that state formations including space blocs will serve as the means through which various states will be able to further their national interests on ground and in space. When nations come together and form space blocs, they are able to reap several benefits. Space exploration is quite hard as it requires the pulling together of various resources and man power to make a significant achievement. The use of space blocs has its own inherent dangers.

Throughout the course of history, there are several examples of rigid alliances that were formed and they faced the challenge of conflict. For instance, it is highly likely that World War 1 was triggered by the growing rigidity of two alliances namely the Triple Alliance and the Triple Entente. This leads us to the conclusion that as long as there are existing space blocs that are flexible and open for all, then it is highly likely that there will be a growing cooperation among states and the world will likely avoid an open conflict in space (Liu & Ihl Woo, 2006). Maintaining international cooperation among nations may require all members to focus on their scientific goals and exchanges between and within the space blocs while ensuring that the political rivalries are kept at bay.

4.2 MANAGING ORBITAL DEBRIS OR “SPACE JUNK”

As space exploration entails travels from earth to space, the release an occurrence of space debris is a common occurrence. Space debris is also known as space garbage, space trash, space waste, space pollution or space junk. They are the defunct man-made objects existing in space, especially within the earth's orbit and are not useful or functional in any way. There are various types of orbital debris that including the derelict spacecraft. It is well known as the non-functional spacecraft or the abandoned launch vehicle stages. They are classified under mission related debris. They are usually enormous within the earth's orbit. Another kind of space debris includes the fragmentation debris produced after the breakup of derelict rocket bodies and space crafts. Other forms of space debris include fragments from the disintegration of space rocks, collisions and erosion of solidified liquids expelled from space crafts (Kobayashi et al., 2019). Unburned particles from solid rocket motors are also classified under space debris. The presence of space debris is not beneficial as it presents a risk to the proper functioning of space crafts. For this reason, they are considered a negative externality. They are known to contribute to the external cost on others due to the initial action of launching or using space crafts near the earth's orbit.

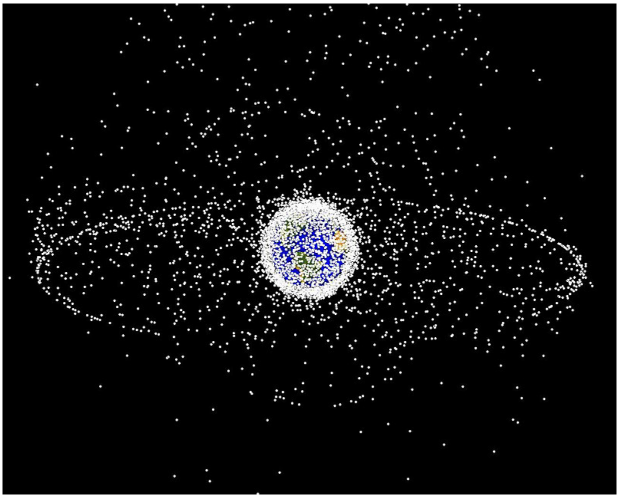

Figure 4.6: Abandoned space crafts are classified as space junk: A computer-generated image representing the locations, but not relative sizes, of space debris as could be seen from high Earth orbit. The two main debris fields are the ring of objects in geosynchronous Earth orbit (GEO) and the cloud of objects in low Earth orbit (LEO).

Source: By NASA image - NASA Orbital Debris Program Office, photo gallery, Public Domain, https://commons.wikimedia.org/w/index.php?curid=52126

In most cases, the cost of the negative externality is usually not taken into consideration or fully accounted for in the total cost by the payload owner or launcher. Damages and destruction of space crafts (crewed and uncrewed) are as a result of space debris. For this reason, it is greatly important to ensure that space debris is removed and disposed of. For this reason, there are participants in the space industry tasked with the duty of conducting the measurement, mitigation and removal of space debris. There is a growing need to ensure the removal of space debris as there are various harmful objects existing in space. For instance, the US Space Surveillance Network reported that as of January 2021 there are about 21,901 artificial objects orbiting above the earth. These objects include 4,450 operational satellites. Some of the objects are small-sized such that they cannot be easily tracked. In 2019, it was recorded that about 128 million pieces of debris whose sizes are smaller than 1 cm were in space alongside 900,000 debris of size 1-10 cm and 34,000 debris with sizes larger than 10 cm(Howe-Walsh & Turnbull, 2016).

Figure 4.7: The presence of debris in space is a hazard to the proper functioning of space crafts.

Source: https://www.shutterstock.com/search/debris

The combination of the small size space debris and grouping it with micrometeoroids are collectively referred to as Micrometeoroid and Orbital Debris. The name was allocated by space agencies. There is a growing number of hazards in space that can be linked to the collision of debris with space crafts. Small space debris are very dangerous as they can cause damage akin to sandblasting more so to optics and solar panels. Most of these instruments cannot be easily protected by ballistic shielding.

There are different kinds of debris found in the earth's atmosphere having different shapes and sizes. For instance, the pieces of debris found 2,000 km below the earth's altitude are denser than meteoroids. It usually comprises dust from solid rocket motors, frozen coolants from nuclear-powered satellites and surface erosion debris like paint flakes. At the 800 to 900 km altitude, the two largest debris events include the Chinese antisat weapon test and the 2009 satellite collision. At the 300-400 km altitude, the International Space Station orbits. To reduce the effects of debris (from small MMOD), the whippleshielding was developed by ISS. This kind of shielding can only deal with small-sized debris. Debris with a collision chance of over 1/10,000 can be avoided by maneuvering the station (Hagendijk & Irwin, 2006).

4.3 VARIOUS SOURCES OF SPACE DEBRIS

4.3.1 Dead Space Craft

Dead space craft include space crafts that were released in space and have not been released. This is the case with the Vanguard 1 that was launched by the United States in 1958. It was launched into a medium Earth orbit. It is regarded as the oldest surviving artificial space object existing in space. There are about 902 operational satellites listed under the catalog of known launches. They form part of the 19,000 large objects and 30,000 objects launched from earth to space. The Soviet RORSAT naval surveillance satellite program is an example of the additional derelict satellite debris launched in the 1970s/80s. After their release, the nuclear reactors of the satellites were cooled by a coolant loop of sodium-potassium alloy (Granato et al., 2014). Though the coolant was useful in reducing the nuclear reactant's temperature, it presented a problem when the satellite reached its end of life. After the launching of satellites, they are usually boosted into medium-altitude graveyard orbits. Many satellites released in space were not boosted as required.

Figure 4.8: A dead space craft.

Source: https://www.shutterstock.com/search/dead-astronaut?image_type=photo

Dead space crafts also include satellites that were properly moved to higher orbits and their coolants released over a certain duration of time. Most of them experienced puncturing. Additional debris was formed after the coolant loop of the sodium-potassium alloy was left in space. The number of debris in space is increased when space crafts explode in orbit as in the case of the USAF Defense Meteorological Satellite Program Flight which exploded and created about 149 debris expected to be found in the atmosphere for a relevant amount of time. There are certain orbiting satellites that were destroyed deliberately contributing to debris found in space.

4.3.2 Lost Equipment

Some of the equipment used by researchers in space are either lost or left in space and is classified as space debris. They include gloves, cameras, garbage bags and thermal blankets among others. There are various scenarios where such equipment were lost in space. For instance, Ed White lost his glove in space during the first American Space-walk while Michael

Collins lost his camera near Gemini 10. Other things lost in space include a toothbrush and wrench (Grupp & Mogee, 2004). All the left equipment in space are classified as debris as they are wastes. Their presence in space is very dangerous as it could affect the space crafts present and function in space.

Figure 4.9: Some items lost in space include gloves and cameras.

Source: https://www.shutterstock.com/search/camera-wallpaper

4.3.3 Boosters

It is notable that most debris found in space are as a result of human activity and boosters are among them. They are classified under debris formed due to rocket upper stages. They are eventually left up in orbit and eventually break up as a result of the decomposition of the invented unburned fuel. There are various examples of space debris left in the form of boosters. Among them is the Ariane booster event. This has led to companies opting to make rockets that do not require launchers. This is an improvement achieved by other space agencies. The presence of boosters as debris has led to the United States and NASA requiring upper-stage passivation. The elimination of boosters has also been done on lower stages such as in the case of the Space Shuttle's solid rocket boosters. It is also the case of boosters that do not reach the orbit as in the case of the Apollo program's Saturn IB launch vehicles.

The presence of boosters in space is very dangerous and contributes to the large number of debris in space. For instance, the Chinese Long March

4 CBERS-1 that exploded on 11 March in orbit. This led to the creation of debris on the Earth's clouds. Other examples include the Russian Briz-M booster which on 19th February of 2007exploded in orbit over South Australia. Some of the debris formed on clouds can be measured while others cannot. Radar is mostly used in measuring the amount of debris left in clouds. The malfunctioning of the Arabsat-4A communications satellite after it was launched contributed to debris on clouds that was immeasurable. The satellite exploded in orbits and the amount of debris left on clouds could not be measured. Later on, about 1,000 fragments of debris were identified as of 21 February 2007. Another issue pertaining booster were the breakups such as the one that occurred on 14 February 2007 and eight break ups that occurred within the span of 12 years (Gandini, 2011). Some boosters released in space led to the creation of fireballs in space as is the case with the Long March 7 rocket boosters. It created a fireball that was visible in various parts of the world including California, Idaho, Colorado, Nevada and Utah. The fireball was due to the disintegration of the booster. The recent occurrence of boosters in space includes the identity of the 2020 SO, confirmed in December as a rocket booster space junk that was initially launched in 1966.

4.3.4 Weapons

In the current day and age, the use of weapons has become more advanced in that nuclear weapons are used. In most cases, the weapons are tested or stored in space. A significant amount of debris has been formed as a result of the testing of weapons in space. A good example is the testing of the anti-satellite weapons by the Soviet Union and the US. The identification of such kind of activity led to the realization that there are various activities done by the North American Aerospace Defense Command. It was, later on, found out that they conducted a number of Soviet test that led to several debris to be identified later on. The major challenge of such kind of debris is that it is not usually identified as quickly as expected (Adamovich et al., 2017). With the ASATs done by the Soviet Union, the problems brought about by the debris were well understood after the Union had ended its widespread ASAT testing. This led to the shutting down of the US program in 1975.

Figure 4.10: Space satellites that are not functional.

Source: By Original image: NASA/Crew of STS-91Retouched image: Thegreenj - http://spaceflight.nasa.gov/gallery/images/shuttle/sts-91/hires/91727051.jpg(http://spaceflight.nasa.gov/gallery/images/shuttle/sts-91/html/91727051.html), Public Domain, https://commons.wikimedia.org/w/index.php?curid=2134900

However, the ASAT programs were later on restarted during the 1980s. This was through the Bought ASM-135 ASAT that led to the destruction to about a tonne of satellites at 525 km. This led to the creation of debris with sizes larger than 1 cm. It was also noted that China among other countries was conducting its own weapon tests in space. The disintegration of the Chinese ASAT led to the debris of planes of Fengyun orbits. This led to the Chinese government being condemned as the disintegration of planes led to various military implications. A significant amount of debris was released in the atmosphere. Some tests that contributed to this was the 2007 anti-satellite missile test and goes down in history as the largest single space debris incident in history. Several satellites have been released in space. A targeted satellite was released and orbited between 850 km and 882 km which is the region or portion of space near the earth. This region is usually densely populated with various satellites. In such space, the atmospheric drag is very low which makes debris very slow to reach the Earth's atmosphere. This led to the June 2007 NASA spacecraft having to maneuver in a certain manner to ensure that it does not collide with debris. In 2007, there was an explosion of the Chinese satellite within orbit that led to the creation of debris of more than 3,000 separate objects all of which had to be tracked to ensure that it does not affect the atmosphere (Ferrari et al., 2015).

Among the different kinds of satellites sent to space include spy satellites. They have contributed to the amount of debris found in space. This led to the US having to send and Launch SM-3 missiles from the USS Lake Erie with the aim of destroying the defective US spy satellites. The spy satellite destroyed on 20th February 2008 was destroyed as it was said to carry 450 kg of toxic hydrazine propellant. The destruction of the satellite occurred at about 250 km thereby leaving debris on the atmosphere. The released missile was launched with the aim of reducing the amount of debris in the atmosphere.

China and U.S. are the well-known countries involved in the release of satellites into space. India is also among the countries that released satellites and missiles in space as it was announced on 27th March 2019 by the Indian Prime Minister. Their missile ended up destroying its own Leo satellite within a ground-based missile. The release of the missile was done with the aim of defending the country's interest in space. Their interest in taking care of their space led prompted the US Air Force Space Command to start tracking 270 new pieces of debris and has continued tracking them. The Kosmos was destroyed by the Russian Defense Ministry. The Kosmos were orbiting their space at height of 450 km. Its destruction led to the creation of about 1,500 pieces of trackable debris while untraceable debris amounted to about hundreds of thousands of pieces (Alexander et al., 2006). The scattering of debris in the atmosphere is very dangerous to satellites as it usually contributes to the damaging of some satellites in space. For this reason, the possibility of debris attacking the Leo satellites and the vulnerability of satellites to debris clouds has created speculation among researchers that nations would be able to make precision attacks on other countries. If a missile were to be launched at a satellite of 10 tonnes, more damages could be imposed on the LEO environment.

4.4 STRATEGIC AND LEGAL CONUNDRUMS OF SPACE TECHNOLOGY

The use of space technology requires proper use therefore proper legal systems have to be put in place to ensure that space is not being misused. The changing world systems make satellites and other space technologies a very important resource to the global economy and military operations. This means that such kind of technology has a dual-use nature. This means that it can be used in civil and military buses. This means that satellites could be used as part of anti-satellite capabilities. This means that there is a need for both legal and strategic strategies to be put in place (Ferguson & Zhang, 2002). It was important for countries to ensure that there are proper methods put in place to ensure that the risks of armed attacks on civilian infrastructure do not seem that most ASAT attacks under the Law of Armed conflict. It was perceived that the use of satellites and space technology would make various countries want to use such kinds of technology to fight. However, many states did not. They are rather using the civil program to help with the development and use of the new technology in overlapping uses. Some of the examples of the strategic and legal framework include the new space capabilities for on-orbit repair, debris management or refueling the management of which could be repurposed to ensure that a collision occurs. The other effect would mean that there would be an interference of space-based assets (Banerjee & Williams, 2013). This means that the dual-use conundrum may significantly affect the security and safety of space, strategic stability and wider protection and defense of civilians on earth. This is a challenge to the international legal perspective that includes the promotion of responsible space behaviors.

4.5 SATELLITE AND SPACE STATIONS

In the field of space exploration, there are both satellite and space stations. In most cases, the satellite stations are located on the ground. They are therefore known as satellite ground stations. They were built to facilitate the collection and streaming remote sensing satellite data. These services are usually available to various users and are used in various areas. Some of the data collected in ground satellites are used in national weather centers including the Bureau of Meteorology or research centers such as the CSIRO. These centers are useful in the collection of weather and other data. In ground satellites, there are various elements considered to be basic to allow their proper functioning. Some of these components include receivers, waveguide, feed horns and reception antenna. In most cases, these components are usually mounted on a pedestal. Such equipment is usually expensive and can be protected by using a radome. The radome is a sphere, which covers the antenna. The antenna of the ground satellites is usually very visible as it is the parabolic dish of the satellite (Floros et al., 2010). There are different dish sizes and shapes all of which are specially designed to accurately direct incoming radio waves from the space satellites. For ground satellites to be fully functional, there need to be space satellites. Space satellites allow the transmission of a broadcast from one ground station to the whole world.

For satellites to exist in space, they have to be launched at a certain altitude in the sky o allow optimal transmission of data. For this reason, a space satellite is referred to as space equipment orbiting the Earth's orbit. Their presence in the sky allows the collection of important information of weather data and transmits the obtained information to ground satellites. The SGS received the collected data which is later on processed and visualized in a computer. Some space satellites are artificial while others are natural. The moon is the Earth's natural satellite. The satellites in space transmit electromagnetic waves to the ground satellites. In most cases, the electromagnetic waves are only a few trillionths of a watt before they get in contact with the Earth's parabolic antenna. The main role of the antenna is to allow the amplification of the incoming signals from space. It is usually specially made such that it does not add noise to the received electromagnetic waves (Foest et al., 2006). The electromagnetic waves are received by the dish in the form of tiny signals thousands of times. They do not have any noise or form of distortion. They are then focused at the center. The received electromagnetic waves are then converted into electrical current. This is done to allow the amplification of the waves by the LNB. The amplification is done to a certain level such that the signals can be processed by the received. This allows the recovery of the 0's and 1's that were initially sent by the satellites.

Space stations are defined as artificial structures launched in the Earth's orbit. These artificial structures are usually specially designed such that they have a pressurized enclosure, supplies, power and environmental systems needed to ensure that human beings living in them are able to survive for longer durations of time. There are different kinds of space stations having different configurations. This means that they are specially made to perform different kinds of activities. Some space stations are used when making observations of the various astronomical objects such as the sun, studying Earth's resource environment, investigations of the behavior of material and biological systems and military reconnaissance. Some of the studies done include the studies on human physiology and biochemistry while in the state of microgravity or weightlessness. There is a variation in the manner in which space stations are launched into space (Badgujar et al., 2008). There are those launched when fully assembled while others are sent at a given state or in modules and the assembling is completed in the atmosphere. Most space stations have a carrier vehicle capacity. To make full use of it, most space stations are launched with an empty carrier vehicle. The members of the crew are launched in different vehicles. The same is done for the extra equipment that they will use. There are cases where space stations are launched while few crew members are carried in it. This was to allow the operation of the space station as it moves. They enable the replenishing or propellant, food, water, air and other items used during normal routines.

As there is no power in space, most space stations make use of large solar panels having solar cells and banks of storage batteries as their source of electrical power. For proper functioning of space satellites, there is a need for continuous communication between the mission controllers in ground and in satellite-based positioning systems and it is facilitated by geostationary relay satellites. This enables proper navigation. Space stations use large panels of solar cells and banks of storage batteries as their source of electrical power. They also employ geostationary relay satellites for continuous communication with mission controllers on the ground and satellite-based positioning systems for navigation.

After space stations have been launched, they have long-duration direct human presence in space. For instance, after the first station Salyut 1and its crew are among the space stations have been in operation consecutively since 1973. This is because they were allowed a progression of long-duration direct human presence in space. Ever since the stations were launched in space, they were occupied by consecutive crews since 1987 with the Salyut successor Mir. The operational transition from the Mir to the ISS allowed the uninterrupted occupation of space stations (Dhillon et al., 2017). The first occupation of ISS began in 2000 and ever since, it has hosted the highest number of people in orbit at the same time. The highest number of human beings in space in 2008 was 13 people.

Currently, there are two fully operational space stations located in the low earth orbit. They include China's Tiangong Space Station and the International Space Station. Ever since October 2000, the International Space Station has been permanently inhabited with the Expedition 1 crews. It was expected that by June 2022, the TSS would begin the continuous inhabitation with the Shenzhou 14 crews. These two stations have different roles with the ISS being used in the study of the effect of spaceflight on the human body. It was also used in providing a location in conducting a greater number and long durations of scientific studies than is possible on other space vehicles. It is expected that by the end of 2022, China's Tiangong Space Station will finish its phase 1 construction. It is also fitted with two lab modules. Russia has its own plan to create its own space stations which led to it withdrawing from the ISS.

4.6 PLANETARY SCIENCES AND SOLAR SYSTEM EXPLORATION

Planetary science commonly referred to as planetology is defined as the scientific study of planets that includes the earth, planetary system and celestial bodies such as comets, asteroids and moons. Planetary science also takes into consideration the formation processes. Planetary science takes into consideration the various objects found in space of different sizes from micrometeoroids to gas Giants. The main aim of planetary science was to determine the history, interrelations, formation, dynamics and the composition of such objects. Planetary science is considered a very strong interdisciplinary field. It originated from astronomy and earth science. Planetary science has undergone much development such that it now incorporates various disciplines that include exoplanetology, glaciology, theoretical planetary science, hydrology, oceanography, atmospheric science, cosmochemistry and planetary geology. There are other allied disciplines of planetary science that include space science. This allied discipline is concerned with the effects of the Sun on bodies of various solar systems. It is also important to note that planetary science also includes interrelated and theoretical branches (Bøe et al., 2011). Observational branches of planetary science takes into consideration that research can involve combinations of space exploration more so with robotics spacecraft missions through the various instruments such as remote sensing. It also includes experimental work in earth-based laboratories. On the other hand, the theoretical component of planetary science involves mathematical modeling and considerable computer simulation.

When looking at planetary science, is located in the department of astronomy and physics or science departments of research centers and universities where planetary scientists work under. Aside from the universities and research centers, there are purely planetary science institutes across the world. Every year, there are several major conferences held. In addition to it, there is a wide range of peer-reviewed journals. There are planetary scientists known to work in private research centers. This has been useful in initiating partnership research tasks.

Among the disciples of planetary science is planetary astronomy and it encompasses both theoretic and observational sciences. In the observational sector, the observational researchers are mostly concerned with the study of the small bodies found in the solar system. Most of these bodies are usually observed using telescopes either radio and optical. This very useful in defining the characteristics of such bodies including the weathering, materials, surface, spin and shape can be determined. It also enables the history of the formation and evolution that can be well understood. On the other hand, theoretical planetary astronomy looks into the dynamics (Doi, 2006). This encompasses the application of the principles of celestial mechanics to extrasolar planetary systems and solar system. In this sense, each planet has its own branch.

The other discipline is planetary geology where most of the research was centered to deal with planetary bodies around the earth including neighboring planets such as Mars and Venus and bodies such as the Moon. The initial study was the moon , which was first studied. The methods used in studying the moon were methods that were initially developed on earth. Much of the emphasis of planetary geology focuses on the celestial bodies exhibiting a solid surface or having a significant solid physical state as a core part of their structure. Geomorphology is also a discipline of planetary earth science. It takes into consideration the features found on planetary surfaces. It also reconstructs the history of the formation of such features which infers the physical processes that acted on the surface. Usually, planetary geomorphology encompasses the study of various classes of surface features that include Aeolian features, glacial features, tectonic and volcanic features and impact features.

It also takes into consideration hydrological features which include the liquids on the Earth's surface. The liquids can range from water to ammonia and hydrocarbon which depends on the location in the solar system. This discipline takes into consideration the study of Paleo hydrological features. It includes space weathering which studies all the erosional effects that were generated by the harsh environment of space such as high-energy particle rain, continuous micro-meteorite and impact gardening. A good example of space weathering is the thin dust cover found on the surface of the lunular regolith which is an effect of the micro meteorite bombardment. Deciphering of mapping features from top to bottom had been useful in depicting the history of a planetary surface (Cao et al., 2006). Mapping is done according to the deposition sequence. There is the stratigraphic mapping which was very useful in preparing the Apollo astronauts for the kind of field geology they encountered during lunar missions.

With regards to space exploration, it has enabled the discovery of other planets in the galaxy. The discovery of the planets in the galaxy paved the way for further space exploration. Scientists are looking to do more space exploration to discover more. This is attributed to the fact there are more planets than stars in the galaxy. Most of these planets are orbiting the sun. The ones that have been well established are eight. Studies show that the inner rocky planets include mars, earth, Venus and mercury. There are various tools that have been used to further space exploration. For instance, the newest NASA's rover landed on Mars on February 18, 2021. Studies later own show that the outer planets comprise the gas Giants such as Saturn and Jupiter and ice Giants including Neptune and Uranus.

From Neptune, the other planets are categorized as smaller worlds. They were all called dwarf planets one of them being Pluto. There are other planets that have been discovered beyond the solar system and have been categorized by scientists as exoplanets. Space exploration has enabled scientists to look into the possibility of other planets sustaining life. A good example is mars. Space Exploration has allowed mars to be identified by scientists as a possible home for human beings (Chadwick et al., 2011). They also look into other planets that could be inhabited by human beings. Space exploration has also allowed scientists to look into the possibility of other galaxies existing and having planets in them.

CHAPTER 5

HEALTH CARE TECHNOLOGY

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INTRODUCTION

Healthcare technology covers medical equipment, IT systems, algorithms, artificial intelligence (AI), cloud computing, and blockchain, among other technologies meant to serve healthcare organizations. During the decades that humanity has been practicing medicine, countless important improvements in health technology have been created, but few have had the effect or influence of digital technology (Borup et al., 2006). Networking and computer technology have achieved enormous advances, transforming the practice of medicine and broadening treatment alternatives.

Despite arguments in the 1960s on the prospective use of computers in medicine, the technology was originally too pricy and unstable for medical practices to rely on. As the technology evolved and costs reduced, rules and data standards were devised to encourage healthcare institutions to utilize contemporary technology for routine record keeping and medical equipment like diagnostic imaging scanners. Paper medical records were digitized and have been largely replaced by electronic health records (EHRs), which make it simpler to acquire health information such as test results and diagnoses securely and straightforwardly. EHR systems and other technologies are being leveraged to engage with patients and construct treatment regimens. In hospital settings, computers and tablets already outnumber stethoscopes, and there is mounting evidence that EHRs are boosting access to and interchange patient data (Bell & Lederman, 2003).

Figure 5.1: Healthcare business concept, medical examination.

Source: https://media.istockphoto.com/photos/healthcare-business-concept-medical-examination-and-growth-graph-data-picture-id1274428125?k=20&m=1274428125&s=612x612&w=0&h=Sq02xTXwuOkFi5tA4uVfeG4hKD-e54R8a7uA7zX7b74=

The gathering of a massive amount of unintegrated and non-standardized data is, however, a considerable difficulty encountered by EHRs. The majority of healthcare organizations have access to a considerable quantity of data that may be employed to strengthen their procedures and operational practices, but they may lack the needed resources or competencies. Large amounts of data may be capable of uncovering trends if healthcare organizations adopt contemporary technologies such as the cloud, blockchain, and AI approaches based on machine learning. Additionally, these technologies can make data safer and more manageable.

As the healthcare business confronts new problems, digital solutions are supporting executives in increasing performance, bolstering system collaboration, and minimizing expenditures. As organizational demands develop, healthcare technology may enhance procedures, automate jobs, and streamline operations to a degree that people cannot (Bengisu & Nekhili, 2006). As hospitals and health systems employ value-based health reimbursement models, these technologies support healthcare staff in strengthening patient care, creating better patient experiences, and decreasing burnout.

Improving patient satisfaction and care

Using technology to capture and analyze data throughout the full patient care system presents healthcare firms with a comprehensive picture of their performance. Technology also helps automate this evaluation so that companies may often check their data, find deficiencies that need to be fixed, and develop techniques to strengthen therapy and the patient experience.

Real-time sharing of information

Numerous diversified stakeholders, including physicians, patients, and payers, desire access to health information for various reasons. Companies have typically been compelled to maintain records for each category separately (Breschi & Catalini, 2010). Nonetheless, as a consequence of contemporary technology that makes it simpler to standardize and preserve digital patient information, a growing number of organizations are integrating their data so that authorized workers may get the papers they need when they need them.

Patients' and physicians' adaptability

Patients are often busy, making it difficult to organize appointments. Telemedicine and patient portals offer new routes of engagement between patients and medical professionals. Additionally, wearable technology, such as heart monitors, allows physicians more possibilities for monitoring patients' health and collecting and evaluating symptoms as patients go about their usual activities.

5.1 PROMINENT DEVELOPMENTS IN HEALTH CARE TECHNOLOGY

Innovative technology may be applied in the healthcare sector to combat disease, generate new vaccines and treatments, and assist people to live better lives. During the past two years, numerous IT businesses have focused on adapting their abilities to the issues posed by the worldwide epidemic. Concurrently, many healthcare enterprises that were not previously considered tech companies have turned their attention to technology and its potential to revolutionize the delivery of their products and services.

The pandemic has pushed the digitalization of the healthcare business. According to the HIMSS Future of Healthcare Report, 80 percent of healthcare providers want to boost their investment in technology and digital solutions over the next five years (Bernardes & e Albuquerque, 2003). Companies will leverage artificial intelligence (AI), cloud computing, extended reality (XR), and the internet of things (IoT) to invent and deliver revolutionary treatments and services in telemedicine, personalized medicine, genomics, and wearables.

5.1.1 Telemedicine and Remote Medical Treatment

During the first six months of the outbreak, the percentage of remote healthcare consultations grew from 0.1 percent to 43.5 percent. According to Deloitte experts, the majority of us are delighted and will continue to enjoy virtual visits. Even if communicable illnesses are abolished, there are multiple strong reasons to expand the capacity to remotely assess, diagnose, and treat patients. This program has the potential to save lives by substantially improving access to medical treatment in rural places and nations where physicians are rare.

To achieve this, next-generation wearable devices are combined with heart rate, stress, and blood oxygen sensors, enabling healthcare practitioners to precisely monitor critical indications in real-time. Even "virtual hospital wards" have been developed as a result of the epidemic, in which a centralized communication infrastructure is deployed to monitor the treatment of numerous patients who are all at home. The Pennsylvania Center for Emergency Medicine's "Virtual ER" pilot is an upgraded version of this concept (Zhang et al., 2018).

In 2022, it is projected that technology invented during the pandemic to safely and remotely treat patients would be implemented in other areas of healthcare, including mental health and the provision of continuing follow-up care for people recuperating from operations and catastrophic diseases. Robots and the Internet of Things are essential components of this movement, and intelligent technology (machine learning) will alert professionals when sensors indicate a need for aid or when cameras observe a senior adult has fallen in their residence.

Telemedicine has the opportunity to extend access to healthcare in a world where, according to the WHO, half of the population lacks access to basic services. However, this is contingent on earning the public's confidence; there are particular instances in which many people continue to feel an in-person relationship with healthcare specialists is vital, hence providers must have this in mind while implementing services (Zeldin et al., 2008).

Figure 5.2: Medical technology concept.

Source: https://media.istockphoto.com/photos/medical-technology-concept-picture-id1127069581?k=20&m=1127069581&s=612x612&w=0&h=5OZ3k9cKeo9Qrg_R4UfSZTaweBi2JnycHSyxPgrAJLA=

5.2 VIRTUAL REALITY-BASED CLINICAL TEACHING AND THERAPY

Virtual reality (VR), augmented reality (AR), and mixed reality is all examples of extended reality. They all use glasses or headsets to alter our perception of the world, either by immersing us in completely virtual environments (VR) or by superimposing virtual components over real-time photographs of the surroundings. All of these have the potential to transform the healthcare industry. Clinicians and surgeons may use VR headsets to become intimately familiar with the inner workings of the human body without putting patients in danger or requiring a supply of medical cadavers.

In addition, virtual reality is used in treatment. This might be part of the treatment because it has been used to educate children with autism on social and coping skills. It has also been used to promote cognitive behavioral therapy (CBT) for chronic pain, anxiety, and even schizophrenia, where therapies are designed to help patients work through their fears and psychosis in a safe, non-threatening environment. In 2022, the number of AR applications in healthcare will grow even more. The AccuVein gadget, for example, is designed to make it simpler for physicians and nurses to find veins when administering injections by monitoring the heat signature of blood flow and marking it on the patient's arm (Wu et al., 2019). Microsoft's HoloLens technology is used in operating theatres to provide surgeons with real-time information about what they are seeing and to allow them to share their perspectives with other professionals or students who may be watching the surgery.

The AED4EU geo layer sends real-time instructions to the nearest publicly available automated defibrillator device. Using artificial intelligence and machine learning can make medical data more useful. The fundamental use case for AI in healthcare, like in other industries, is to assist in making sense of the massive amount of messy, unstructured data that is available for collecting and analysis. This contains X-rays, CT and MRI scans, information on the spread of infectious diseases like covid, vaccination distribution, genetic data from living cells, and even handwritten physician's notes.

Current medical discoveries associated with the application of artificial intelligence often require the augmentation and up skilling of human specialists. As mentioned in the preceding section, surgeons using augmented reality are assisted by computer vision - cameras that can detect what they are looking at and relay the information. Automating initial patient contact and triage to free up physicians' time for other crucial duties is an important use case. Chatbots powered by artificial intelligence and natural language processing are used by telehealth companies such as Babylon Health to collect symptom information and route inquiries to the appropriate healthcare professionals.

Artificial intelligence will have a significant impact on preventative medicine in the next years. Rather than treating illness after it has occurred, preventive medicine attempts to predict where and when illness will develop and to put solutions in place before it occurs. Predicting where outbreaks of contagious diseases will occur, hospital readmission rates, and where lifestyle factors such as diet, exercise, and environment are likely to lead to health issues in different populations or geographical areas are all examples of this. AI enables the development of algorithms that can detect patterns in massive datasets far more efficiently than traditional analytics approaches, leading to more accurate forecasts and, ultimately, better patient outcomes (Woolgar & Lezaun, 2013).

5.2.1 Digital Twins and Simulations

Digital twins are quickly gaining popularity in a variety of industries, as part of a trend that involves developing models influenced by real-world data and capable of replicating any system or process.

Figure 5.3: Aerial view of crowd connected by lines.

Source: https://media.istockphoto.com/photos/aerial-view-of-crowd-connected-by-lines-picture-id1180187740?k=20&m=1180187740&s=612x612&w=0&h=s5vqexDzwt8irE-SC1wLWUUDompG9ehBDPrGTe5SsSU=

This idea in healthcare involves the concept of the "virtual patient" - computer models of people used to test drugs and therapies to reduce the time it takes to bring new medicines from the design stage to general usage. Initially, this may be limited to models or simulations of specific organs or systems. However, progress is being made toward workable models that replicate full bodies. According to current studies, this is still a long way from becoming a realistic alternative, but we will see development toward this aim in 2022.

Human organ and system digital twins are becoming a reality, allowing physicians to examine various disorders and test medications without endangering individual patients and reducing the need for costly human or animal research. The Living Heart Project, which started in 2014 intending to create an open-source digital twin of the human heart, is an excellent example (Antal & Grønli, 2003).

Similarly, the Neurotwin project, a European Union Pathfinder initiative, investigates the

interplay of electrical fields in the brain, intending to develop novel Alzheimer's disease therapies. Digital twin technology has been identified as one of the most important healthcare tech trends for 2022 due to its ability to help the healthcare sector develop cures more quickly and cost-effectively.

5.3 CUSTOMIZED MEDICINE AND GENOMIC MEDICINE

Drugs and therapies have traditionally been developed on a "one-size-fits-all" basis, with research aimed at optimizing pharmaceuticals for efficacy with the greatest number of patients while avoiding unpleasant side effects. Modern technology, such as genomics, artificial intelligence, and digital twins, allows for a much more personalized approach, resulting in medicines that can be tailored right down to the individual level. For example, the Empa healthcare facility in Sweden uses AI and modeling tools to determine the optimal amount of drugs, including synthetic opioids like fentanyl, for individual patients (Adamovich et al., 2017). For people suffering from chronic pain, these can be extremely therapeutic and life-changing, but in high doses, they can be extremely dangerous.

Novo Nordisk has collaborated with digital health company Glooko to create personalized diabetes monitoring tools that provide individualized advice for diet, exercise, and disease treatment based on patients' blood sugar levels and other data that is unique to them.

Genomics - the study of genes and, in particular, the use of technology to map individual genomes (the DNA structure of an organism, such as a human) - is especially useful for developing personalized medicine. This is swiftly leading to innovative therapies for key ailments such as cancer, arthritis, and Alzheimer’s disease. Nutrigenomics is a genomics sector that will see significant investment and advancement through 2022; it entails designing individualized health-focused dietary regimens based on various genetic traits.

Many current projects involving the use of artificial intelligence in healthcare are focused on clinical decision support and extracting valuable insights from massive amounts of data. Healthcare organizations have amassed so much data that interpreting it without AI would be difficult. AI-enabled technology can sift through massive and complex data sets generated by electronic records, notes, photographs, sensors, and devices to identify trends that can improve patient care and assist researchers in developing new treatments for medical conditions. Although AI technology is still in its early stages, there are a variety of use cases that could help organizations across the healthcare industry (Alexander et al., 2006).

In the healthcare industry, blockchain technology provides a user-centered solution for securely gathering, confirming, and exchanging health information. Most blockchain systems provide a distributed ledger of records that cannot be changed without having the changes recorded. The technology has the potential to anonymize and protect patient data while also providing complete transparency and interoperability across disparate, distant, and highly fragmented healthcare systems.

5.3.1 Telemedicine

In the 1950s, a small group of medical institutes and hospital networks began researching ways to exchange information via telephone, laying the groundwork for the development of telemedicine. One of the earliest examples of successful implementation was the ability of two healthcare facilities in Pennsylvania to transfer radiological photographs over the phone.

When it first became available, technology was used to connect physicians treating patients in one location with specialists in another. This was the start of telemedicine. People who lived in remote or inaccessible areas appreciated this because specialists are not always easily accessible in those areas (Wang, 2009). Despite increased use, the technology required to conduct remote visits remained prohibitively expensive and difficult to implement over the next several decades.

The practice of telemedicine experienced a significant paradigm shift as a direct result of the digital revolution. Patients who live too far away to travel to a healthcare provider's office can now receive the same level of general and specialized care through the use of high-tech devices with high-quality video transmission capabilities.

- Telemedicine includes telehealth

Despite their common interchangeability, telehealth and telemedicine are two distinct but related fields. The term "telehealth," which refers to a broad range of medical technologies and services, has the potential to improve almost every aspect of the healthcare delivery system. This is because the term encompasses a wide range of medical practices. There is a distinction to be made between telemedicine and telehealth because the latter provides a broader range of services (Wynne, 2007). Furthermore, telehealth can be used for non-clinical purposes such as healthcare professional training, board meetings, and continuing medical education (CME). On the other hand, clinical operations performed at a distance rather than in a traditional hospital setting are referred to as "telemedicine," which is another usage of the term.

Monitoring, health promotion, and public health efforts are all examples of what can be accomplished with telehealth, according to the World Health Organization. Telemedicine is the process of providing treatments to patients without the need for an in-person consultation through the use of software and electronic connections. This is accomplished by utilizing telehealth. Telemedicine technology is widely used to manage follow-up visits, chronic illness management, medication administration, specialist consultation, and a variety of other healthcare services that can be performed remotely using secure video and audio communications.

5.3.2 IoT Devices

We can take the internet with us wherever we go thanks to IoT devices. There are several IoT gadgets available for businesses, industries, and healthcare that can be used to create a seamless experience where we work and play. This post will teach you everything you need to know about the Internet of Things devices. Give a thorough description of them. How do they work? What advantages can you anticipate from the Internet of Things (IoT) devices? Now is the time to get started.

What Precisely Are IoT Devices?

Many people today can recall a time before the internet was even a concept. The Internet of Things is pushing connectivity and computing closer to the edge. Devices designed for the Internet of Things (IoT) can send data over networks and the internet, which is why they are referred to as IoT devices. These devices come in a variety of shapes and sizes, and they can be used for a variety of purposes. The Internet of Things may include a wide range of different types of devices (IoT).

Unlike PCs and other non-portable installations, users can take IoT devices almost anywhere. They enable users to collect and analyze environmental data through the use of machine learning AI. Among the most popular IoT products are smartwatches, home security cameras, and smart home gadgets such as Amazon Alexa and Google Nest(Woellert et al., 2011).

IoT devices have the capability of performing a wide range of functions. They enable people to lead more active lifestyles through the use of implants and other gadgets; they assist businesses in avoiding operational bottlenecks through the use of sensors and predictive analytics, and you can even remotely control the temperature of your home with their assistance.

What Applications Do IoT Devices Have?

To better understand how the Internet of Things (IoT) devices can simplify human activities and lifestyles, no prior technical knowledge is required.

An Internet of Things device is essentially a small computer that communicates with the internet. The cloud determines what to do with the processed data. Depending on the data flow, the cloud software may raise an alarm, change a sensor, or display a warning (Banerjee & Williams, 2013).

IoT devices are pre-programmed to run autonomously, with no human intervention required other than programming. The user interface, on the other hand, varies in usefulness. Certain tasks can be completed automatically, whereas others require human intervention before they can be completed.

The IoT system accepts changes made by the user and sends them to the device, which then executes the instructions. Ignoring the warning, noticing anomalous behavior, or contacting the employees on-site are some examples of how to do this.

Figure 5.4: Science technology concept.

Source: https://media.istockphoto.com/photos/science-technology-concept-laboratory-examination-research-picture-id1180547354?k=20&m=1180547354&s=612x612&w=0&h=p6vNeJtfq4RdqStutVnVFi8bP_P6ln9_3P4hdaDhE0o=

Let's look at how an IoT system works to better understand how IoT devices work. An Internet of Things (IoT) system is made up of four components that allow IoT devices to carry out their programming:

In a variety of ways, IoT devices can collect data and information about their surroundings. Data can be collected using a variety of methods, including cameras, accelerometers, and GPS, among others. A smart home device can detect heart rate, acidity, and other chemical data, whereas a motion sensor detects vibration patterns in large machinery.

- Connectivity

A sensor-equipped Internet of Things device sends environmental data to the cloud. Connectivity transports data to the cloud. A variety of technologies, including WiFi, Bluetooth, satellite, cellular, and even 5G, can connect IoT devices to the cloud (Whitcombe et al., 2014).

Numerous factors influence how well a device integrates into the Internet of Things (IoT). A network-enabled device cannot function unless it has Internet access. This means that gathering data from IoT devices is pointless unless it can be processed in the cloud and analyzed further. Connectivity is essential to the Internet of Things.

- Information analysis

Processing begins after a connected IoT device sends data to the cloud. To effectively transfer qualitative data, computers must adhere to specific standards when reading, analyzing, evaluating, and acting on inputs. By converting raw data into a machine-readable format, cloud-based data processing enables IoT devices to determine their next course of action.

IoT devices are programmed to detect and collect various types of information to carry out predetermined tasks and functions based on these datasets. The cloud's ability to analyze and interpret data is based on its data processing capabilities(Verbeek et al., 2002). A simple task like checking the temperature could be performed here, as could a more complex one like using computer vision to identify safety issues.

- A user's point of view

What use is data if you can't do anything with it? The majority of IoT devices that have a user interface facilitate user interaction (UI). After data processing is completed, the UI generates and displays output for the user. An IoT device can produce a result in several ways.

If the motion is detected at a location after business hours, an SMS alert can be sent to the business owner. If the temperature in the cold storage unit becomes too high, an IoT device may issue a warning or, if certain conditions are met, may immediately take action.

If there is no automated protocol, consumers can tell the IoT device what to do next by using the user interface.

5.3.3 Virtual Reality Surgical Training

Doctors may use virtual reality (VR) to learn and evaluate their abilities before operating on patients, a new technique. Additional advantages of employing virtual reality include the possibility for students to perform the same method or activity several times. New skills in laparoscopic surgery are taught to the surgeon through a video monitor as they are done on the patient. As a result, the requirement for expensive animal training models might be avoided through the use of virtual reality simulations. A virtual reality (VR) learning environment for surgeons, replete with model tissues and laparoscopic devices, is within our capabilities, according to our first findings (Badgujar et al., 2008). An additional need is the appraisal of competency. Surgical training needs a 5-7-year apprenticeship under careful supervision. Tech abilities are subjectively appraised in this manner by mentor and student.

For VR surgical simulators to be effective in the future, quantitative evaluation of proficiency must be included in the system. Fuzzy logic might be used to quantify surgical competency in a virtual reality surgical simulator since surgical competence is “vague,” using terms like “too long, too short” or “too near, too distant.” Due to the number of activities and processes required in a surgical operation, we’ve chosen to employ a virtual reality (VR) simulator to design and test two important duties. Suturing and knotting in the uterus through laparoscopy are also covered in this list. Using fuzzy logic and virtual reality, we believe surgeons may be educated to do these surgeries and judge when they are ready to do so.

5.4 MEDICAL RECORDS IN DIGITAL FORM

In the electronic health record (EHR) of a healthcare provider, the medical history of a patient is recorded in digital form and updated over time. An EHR may contain all of the administrative clinical data necessary for a patient’s treatment under a single provider, including demographics, progress notes, problems, and prescriptions, vital signs, past medical histories, vaccines, test findings, and radiology reports. Using the EHR, physicians will be able to access information faster and more efficiently. Additionally, the EHR may aid with other elements of patient care, like quality control, outcome reporting, and evidence-based decision-making, via several interfaces.

Medical technology’s next important step toward greater patient-doctor communication is electronic health records (EHRs). Health care providers will be better equipped for their work owing to the fast and easy access to the data. For instance, the EHR can improve patient care by making health information accessible, reducing test duplication, reducing treatment delays, providing patients with the information they need to make better decisions; Reducing medical errors by making medical records more precise and easy to comprehend; and providing patients with the information they need to make better decisions (Terrones, 2003; Sismondo, 2018).

Figure 5.5: Medical technology concept. Remote medicine.

Source: https://media.istockphoto.com/photos/innovation-and-science-concept-picture-id1177116437?k=20&m=1177116437&s=612x612&w=0&h=3aeSq8Wv-6gcpFzuUz40e62Xs_zKMDuSLDz79BshuZg=

5.5 ELECTRONIC PHARMACEUTICAL PRESCRIPTIONS

This year's Physician Fee Schedule Final Rule implements phase 2 of the SUPPORT Act's Section 2003 rule, which requires that Medicare Part D prescriptions for Schedules II, III, IV, and V restricted medications be generated electronically. The Secretary may provide EPCS exemptions and exclusions, and the Act specifies the sorts of exclusions that may be granted (Bøe et al., 2011). It also empowers the Secretary of Health and Human Services to enforce the legislation and impose appropriate penalties for noncompliance.

Where the prescriber and dispensing pharmacy are the same entity; For prescribers who issue less than 100 controlled substance prescriptions for Part D drugs per calendar year; or For prescribers granted a waiver due to unforeseen circumstances.

Doctors must be able to submit prescriptions electronically that are error-free and intelligible at the point of treatment. This is known as E-Prescribing, and it is critical for enhancing patient care. The inclusion of electronic prescribing in the Medicare Modernization Act (MMA) in 2003, as well as an Institute of Medicine report in 2006 on the significance of e-prescribing in lowering pharmaceutical mistakes, has increased public awareness regarding the function of e-prescribing in enhancing patient safety. Implementing electronic prescription standards is a critical step in the US government's attempts to accelerate the adoption of electronic medical records and build a national electronic health information infrastructure.

The MMA established an optional new Medicare Part D prescription medication program. If drug plans engage in Medicare Part D, physicians and pharmacists will be required to use e-prescribing, even if it is voluntary for the two professions.

5.6 HEALTH INFORMATION TECHNOLOGY

The term "health information technology" (health IT) refers to the electronic technologies used by healthcare professionals, as well as increasingly by patients, to store, transfer, and analyze patient data. EHRs enable doctors to better manage your medical information and may allow them to access it even when their office is closed to assist you if an issue arises. EHRs also make it easy for your doctor to share data with specialists, ensuring that the professionals who need your data have access to it when they need it. A PHR is similar to an EHR, except that you have control over the data that is entered into it. A personal health record (PHR) can be used to record information from medical appointments, but it can also represent your life outside of the doctor's office and your health priorities, such as keeping track of your diet, exercise routine, and blood pressure. Your PHR may be linked to your doctor's EHR regularly (Shannon et al., 2010). A written prescription might be misplaced or misinterpreted. E-prescribing allows you to communicate directly with your doctor and pharmacist. This means you don't need to bring the paper prescription with you when you go to the pharmacy to get your prescriptions. Privacy and security. All of these technological solutions can help to keep your health information more secure. For example, electronic data can be encrypted so that only authorized individuals can read it. Furthermore, health IT can make it simple to track and document who has accessed your information.

5.6.1 Integrating Health ITsm

The US Department of Health and Human Services' Office of the Countrywide Coordinator for Health IT (ONC) has launched a multimodal, nationwide education campaign to emphasize how individuals are putting the "I" in health ITSM. The campaign aims to simplify the difficult topic of health information technology and make it simpler for readers and viewers to relate to the tales of the country's transition to an electronic health care system. Among the many examples are Prescriptions that are more precise and timely: By using e-prescribing systems, which automatically transmit prescription orders to the pharmacy on your behalf, you may save time by having your medication ready for collection when you arrive. E-prescribing reduces the possibility of pharmacological mistakes, such as those caused by poor handwriting on a paper prescription. Rapid information exchange: When a healthcare practitioner uploads patient notes or test data to your EHR, such changes may be visible to other healthcare professionals with access to your information. This gives them the most up-to-date information about your health (Suryanarayana et al., 2001).

Some healthcare providers may allow you to immediately access your health information, which means you won't have to wait to learn about test results from your doctor. Reduced paperwork: As a patient, you've most likely filled out innumerable forms requesting the same information about your personal information and medical history. You might save time by not having to copy down the same information over and over again when healthcare providers communicate your electronic health information. There were fewer unnecessary tests ordered: Because the results of previous exams were difficult to get, physicians sometimes ordered tests that you had already completed. If all of your test results are stored in EHRs that can communicate with one another, your doctor may prescribe just the tests and treatments that are truly necessary. This will save time, money, and trouble while also minimizing the risk. Improved follow-up and execution: Many EHRs provide reminder systems for both you and your doctor. Some EHRs, for example, encourage your doctor to check on you about ongoing medical issues or to provide you with information or services in response to changes in your health. Some EHRs can also send you email or text message reminders to arrange and attend appointments, take prescribed medications, and perform other health-related tasks.

If you need to relocate, whether temporarily or permanently, having your information in an EHR should make it simple to rebuild your records and make them accessible to physicians outside of your current location. Secure information access: For professionals and other people you choose to have access to the specific data they need to manage your care, approved systems must fulfill certain Federal security standards; further safeguards may be required by State legislation. Keeping Your Privacy Safe. Taking Care of Your Health. Protecting the confidentiality and security of protected health information is important to patients, their families, healthcare providers, and the federal government (Swierstra & Rip, 2007). Numerous noteworthy individuals and organizations who handle health information are required by federal law to implement security measures to protect it, whether it is stored electronically or on paper.

Since the initial Institute of Medicine (IOM) research, health information technology has developed and been more widely used, with varying degrees of evidence on its impact on patient safety. The goal of this article is to assess the most recent scientific studies on the impact of various health information systems on patient safety outcomes. We find that health information technology improves patient safety by reducing prescription errors, reducing adverse pharmacological reactions, and increasing adherence to recommended interventions. There is little question that health information technology is a vital tool for enhancing healthcare quality and safety. According to research, some of these investments may not significantly improve patient safety outcomes, therefore healthcare institutions must exercise caution when deciding which technology to invest in.

A subset of patient safety is the prevention, mitigation, and amelioration of negative outcomes or injuries caused by healthcare procedures. Error is human, according to a 1999 Institute of Medicine (IOM) report, which recommended developing and testing novel techniques to reduce medical errors. The Institute of Medicine (IOM) recommended using information technology as a critical first step in changing and reforming the healthcare environment to obtain better and safer treatment in its 2001 study, crossing the Quality Chasm.

The application of information processing, including both computer hardware and software, to the storing, retrieval, exchange, and use of health care information, data, and knowledge for communication and decision-making is defined as healthcare information technology (HIT).

Health information technology encompasses a wide range of systems, from simple charting to more complex decision support and connection with medical equipment. Health information technology offers several opportunities for improving and innovating healthcare, such as reducing human error rates, improving clinical outcomes, allowing care coordination, increasing practice efficiency, and tracking data over time (Small, & Klavans, 2014). Since the initial IOM study, there has been significant development and acceptance of health information technology, and there is now a range of data addressing how this technology affects patient safety.

5.7 ELECTRONIC PRESCRIPTIONS AND DOCTOR'S ORDERS ARE SENT BY EMAIL

The submission of medical orders, such as prescriptions for medication, via a computer or mobile device, is known as computerized physician order entry.

Furthermore, modern technology makes ordering tests, treatments, and consultations easier. Initially, automated physician order entry systems were created to improve the safety of pharmaceutical orders. A clinical decision support system (CDS) is often connected with computerized physician order entry systems to reduce errors by advising the prescriber on the right prescription amounts, routes, and administration frequencies (Rao & Cheetham, 2001). Furthermore, some CPOE systems may notify the prescriber of patient allergies, drug-drug or drug-laboratory interactions, or, in the case of more sophisticated systems, interventions that should be prescribed based on clinical guideline recommendations (for example, venous thromboembolism prophylaxis) (for instance, venous thromboembolism prophylaxis).

Clinical decision support gives healthcare practitioners access to both generic and patient-specific data. This data is carefully filtered and made available to healthcare professionals only when they need it, to improve their capacity to make educated decisions. Several clinical decision support technologies can help with clinical workflow and decision-making. Examples include clinical advice, condition-specific order sets and summaries, documentation templates, and aid with investigations and tests. These tools can help healthcare practitioners and patients keep informed, on top of things, and organized. When on-screen reminders were employed, doctors' adherence to processes, pharmaceutical orders, vaccination orders, laboratory orders, and so on increased only a little, according to Cochrane's thorough review.

Typically, physicians overlook clinical decision support system messages. A recent study found that prescription physicians in the Boston area ignored 33% of drug warnings. Tiering and alert automation increased physician adherence to CDS alert by boosting physician adherence to diverse CDS system upgrades, according to many clinical trials. According to a meta-analysis of the reasons why certain CDS systems function and improve patient outcomes while others do not. CDS systems that require healthcare professionals to justify deviations from CDS counsel are more likely to succeed than systems that just offer advice. Furthermore, CDS systems that gave guidance to both practitioners and patients were more likely to succeed (Porada et al., 2013). The success rate of CDS systems, when reviewed by their developer, is considerably higher than when examined by an impartial developer. Even though published studies repeatedly and reliably reveals that CDS systems improve patient safety and quality of care, the effects may vary depending on the system design and deployment method employed.

5.7.1 Electronic Instruments for Signing Out and Giving Over

To maintain continuity of care and patient safety, sign-out or "hand-over" communication is the transmission of patient-specific information from one caregiver to another, one team of caregivers to another, or caregivers to the patient and family. A botched transmission of patient data is one of the most prevalent causes of sentinel events in the United States. Electronic sign-out applications are devices that can be used alone or in conjunction with an electronic medical record to ensure that patient data is transmitted in an orderly manner during provider handoffs. According to two systematic reviews, the majority of studies supported the use of electronic tools to improve physician shift-to-shift handoffs in terms of improved handover procedure, fewer omissions of vital patient information, and decreased handover duration(Pahlavan & Makela, 2002). A few low-quality studies looked at patient outcome indicators. According to the authors of both assessments, a large percentage of the included studies were not properly constructed, emphasizing the need for additional research using rigorous study designs.

Medication is distributed using bar codes.

These electronic systems combine bar code technology with computerized pharmaceutical delivery records. These systems are intended to reduce medication errors by ensuring that the correct medication is given to the correct patient at the correct time. There are numerous barcode systems in use today. Some software can generate alerts when drugs that sound or look alike may be mistaken for one another. While some labels may provide expert advice for specific prescriptions, others may aid in documentation.

Figure 5.6: Vigilantly monitoring his patient's vitals.

Source: https://media.istockphoto.com/photos/vigilantly-monitoring-his-patients-vitals-picture-id592647720?k=20&m=592647720&s=612x612&w=0&h=7w74WizjriwUAX_yf9utV6m-ZVsmip8Cd5f9HVsu7xA=

There was no randomized, controlled clinical research on barcode medicine delivery or closed loop drug administration that we could find in the literature. The most reliable clinical evidence for this strategy comes from observational or quasi-experimental studies. According to a comprehensive review of quasi-experimental studies, bar code medicine distribution may reduce drug administration errors by 50 to 80 percent. The systematic review, on the other hand, did not investigate whether the methodology of the included study had been evaluated for quality. Because most studies have taken place in adult inpatient facilities, the utility of barcode technology in pediatric and outpatient settings is less well-studied than it could be. Another systematic review found that a meta-analysis of trials including BCMA reduced medication errors by 57%. Because of the large number of studies included in the meta-analysis, this conclusion should be taken with a grain of salt (Otsuka & Kakeshita, 2002). Even though BCMA automates and improves prescription delivery documentation, clinical data supporting its usefulness in reducing medication errors is moderate to insufficient. Before drawing any conclusions, a thorough investigation must be conducted. It is also critical for healthcare businesses to consider how the BCMA will affect their daily operations.

5.8 INSTILLING INTELLIGENCE IN THE SYSTEM

Using an intravenous infusion pump equipped with a smart computer can help to reduce medication errors. When a user violates a predefined set of safety parameters, an alert is sent to him or her. According to the single published randomized controlled trial, activating or deactivating the smart pump's decision assistance component had no statistically significant effect on drug safety. According to the study authors, a lack of adherence to infusion guidelines by healthcare staff may have been a contributing factor. According to a comprehensive review of quasi-experimental studies, smart pumps may reduce programming errors but not eliminate them. According to an evaluation, strict rules outperform lenient ones in terms of reducing pharmaceutical errors (Nisbet et al., 2002). The high frequency of soft limit overrides can explain this phenomenon. More research is needed before we can draw firm conclusions about the efficacy of smart pumps in reducing medication errors and improving patient safety.

5.9 USING AN AUTOMATED METHOD TO DISTRIBUTE MEDICINE

Automated dispensing cabinets (ADCs), as the name implies, are electronic drug cabinets that store medication at the point of treatment and allow for regulated dispensing and distribution tracking. Automated dispensing cabinets, first used in hospitals in the 1980s, now contain increasingly complex software and digital interfaces to simplify high-risk aspects of pharmaceutical administration. Medicine dispensing cabinets with automatic dispensers have been successfully implemented to assist with pharmaceutical inventory management by reducing stress on the central pharmacy and improving medication dispensing and patient invoicing tracking. So far, they've had a lot of success. According to the findings of one published randomized controlled trial, the use of ADC reduced medication errors in a critical care unit by 28%. A thorough investigation revealed that the vast majority of errors were the result of poor planning (Moore, 2013). The automated dosing system was unable to prevent injuries caused by human error. Automated dispensing cabinets have been shown to reduce medication preparation errors in critical care settings. Only critical care settings have access to a high-quality dataset. More controlled research is needed to assess the impact of ADC on pharmaceutical safety in various contexts.

5.10 SURGICAL EQUIPMENT PREVENTATIVE TECHNOLOGY

RFID tagging and barcoding are two of the many methods used to reduce the risk of surgical supplies being left behind after surgery. A systematic review found three publications that evaluated technology to prevent surgical objects from being left behind. A randomized controlled experiment on the use of barcode-assisted sponge count technology found no difference between the two groups, despite the intervention group taking longer to complete the count. Another study found that the use of RFID tagging of surgical instruments had no statistical significance. Unfortunately, there haven't been enough clinical trials to determine whether this technology is beneficial or harmful (MacIá, 2005). The use of RF and RFID systems cannot be considered a stand-alone operation due to a variety of issues, including cost, confusion with older non-tagged objects, and the wand method with these systems.

5.11 PATIENTS' ACCESS TO E-HEALTH PLATFORMS

Patient portals are web-based applications that enable patients to securely access and communicate with their healthcare providers via computer or mobile device, as well as view and update their personal health information.

Several studies have demonstrated patients' ability to self-manage their health, learn about their condition, and engage in preventative care. However, there is no evidence to support the claim that they improve patient outcomes.

CHAPTER 6

THE IMPACT OF DIGITAL TECHNOLOGY ON GLOBALIZATION

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The usage of digital technology has enabled new work and play styles, global business networks, and an abundance of data. Predictive analytics is driven by AI, the internet of things (IoT), and visualization all of which provide previously unachievable insights and new ways to engage with one another. These technologies are also causing havoc in a variety of sectors by radically changing demand and supply chain dynamics (think of the rise of platforms like Uber or global online marketplaces such as Amazon or Alibaba) (Martin, 2010). Naturally, many individuals gain from this, but it frequently comes at the expense of others, such as steelworkers who lose their jobs to a less-priced competitor overseas.

Figure 6.1: Exchanging data blue digital technology innovation computer network.

Source: https://media.istockphoto.com/photos/exchanging-data-blue-digital-technology-innovation-computer-network-picture-id1343315703?k=20&m=1343315703&s=612x612&w=0&h=2mHfEy81GNFOQE5d2Rma9NyANfioB-HBzmRlLfyQ_zo0=

As a result, while digitization is an important factor in globalization, it is not the only one. Increasing online business-to-business transactions and even rethinking shipping through the use of blockchain technology might minimize friction in international trade. Monitoring and a well-planned strategy are required, just as they were with globalization (policy).

Organizations and industries are undergoing massive transformations as a result of globalization’s effects on how they manage supply chains and invest in new goods and services. Because of advancements in information technology and information systems, many U.S. organizations’ global business strategies increasingly rely on their capacity to communicate and process information digitally (Liu & Zhang, 2011).

The world and their company will become increasingly entwined as a result of their better information technology and information systems, which are vital to the success of any multinational corporation. They may be found in anything from desktop computers to cellphones, as well as hardware and software. Businesses may better connect to other nations' information networks and realize their full economic potential by using these tools. The Internet and Internet-based solutions advance globalization by making global communication and information sharing simpler than ever before. Hardware and software have played an important part in globalization by linking systems and people all over the world. As artificial intelligence has advanced, computer systems that can do tasks typically designated for humans have been created. Cognitive talents include language translation, decision-making, speech recognition, and visual perception. When these abilities are established in a computer system, it is simple to continue developing internationally in a variety of ways. Businesses may save time and money by expanding operations without hiring or training new staff by utilizing a computer system with visual perception, speech recognition, and decision-making capabilities. The system is designed to handle location-specific inquiries due to fewer human errors and linguistic obstacles as a result of meticulous planning of strategy and task analysis in advance (Lieber, 2003). When a company's global strategy demands conducting business in areas where English is not the dominant language, language translation can be extremely valuable. "Multinational enterprises' distant activities can interact with one another fast" using these information technologies.

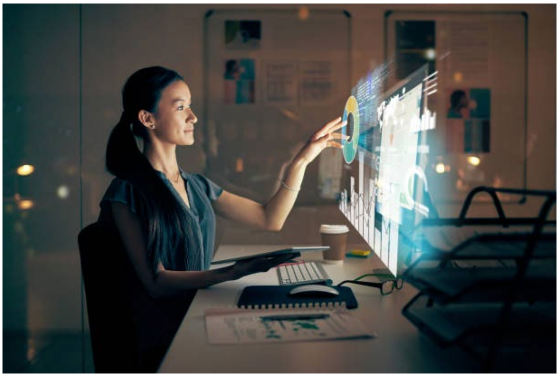


Figure 6.2: Software development.

Source: https://media.istockphoto.com/photos/software-development-after-sundown-picture-id1152446348?k=20&m=1152446348&s=612x612&w=0&h=o9LLU8LHO1aPykFO2lM7vRdw2-RN_y_d2ztR58FmclI=

When a firm or industry competes in the global commercial sphere, it needs quick and trustworthy international communication. The development of new information technology has had a significant impact on the spread of globalization via technologies such as mobile phones, networks, and personal computers. As a result of these changes, companies may now participate in more frequent and diverse ways than ever before, making global trade far more feasible and less demanding. Employees may utilize their mobile devices to engage with one another via instant messaging, email, and phone conversations to do their tasks effectively and quickly. Because of computer networks, multinational enterprises may now deliver worldwide, timely services. As an example, consider when a consumer makes a request that is subsequently made public to the entire globe. Because the strategy is so effective, the buyer is unaware that their case is being handled in another country (Liu & Ihl Woo, 2006). Because of advancements in information technology and systems, global enterprises may achieve time and location independence. As a consequence, businesses will be able to digitally integrate their whole supply chain, from sales to manufacture to delivery, into a uniform flow of information that can be viewed from any place at any time.

Converging technologies reflect historically distinct disciplines that are evolving toward greater interconnectedness and common goals. Emerging technologies are technological advancements that indicate the expansion of a field to gain a competitive advantage. However, opinions about the significance, usefulness, and commercial viability of many emerging and converging technologies differ. Proponents of technological transformation typically see emerging and converging technologies as promising for improving the human condition. While Man has remained essentially unchanged throughout human history (genes change very slowly), all significant change is a direct or indirect result of technological innovation (memes change very quickly), as new ideas are always the result of utilizing technology rather than vice versa, dangers of technological progress, I warn that some of these technologies may be dangerous and have the potential to wipe out humanity as we know it. Alternatively, some of these technologies may pose existential threats. Access to beneficial types of technology is a difficult ethical issue (Kobayashi et al., 2019). Some intellectuals, are opposed to the continuous development of cutting-edge technology because they believe its benefits will be distributed inequitably, exacerbating the disadvantaged's plight. Improved information technology and procedures have resulted in a more internationally competitive corporate environment, leading to globalization. Organizations are increasingly understanding the significance of spreading their technology and information systems across borders to compete in the global economy. Globalization is being driven by information technology and information systems, which allow goods and services to be distributed to clients all over the world.

Globalization has accelerated tremendously as a result of technological breakthroughs. Technological advancement has been one of the driving forces behind globalization. Companies are being pushed to expand globally as economies of scale and the size of the break-even market grow. Technological improvements have made it simpler to obtain raw materials and other inputs all around the world by lowering the cost of international travel and communication. Patent-protected technology facilitates globalization because patent holders profit from limited competition in overseas markets. Global society is being shaped by digital technology. Because of the internet, for example, there are no longer geographical or temporal limits on commercial ties (Howe-Walsh & Turnbull, 2016). Buyers and sellers can now transact at any time of day or night, from any location on the planet. Changes in technology influence investments just as much as anything else.

Figure 6.3: Machine learning hands of a robot.

Source: https://media.istockphoto.com/photos/machine-learning-hands-of-robot-and-human-touching-on-big-data-picture-id1206796363?k=20&m=1206796363&s=612x612&w=0&h=IapYt1UYr9kJGX7gunSjksvAGiiqF6DzB0G-Vo-BgLeE=

Until recently, only wealthy economies could afford to research and manufacture cutting-edge technologies. Transferring technology to low-income nations, where high-tech firms may coexist with low-wage occupations, is now a simple and uncomplicated procedure. Companies in affluent nations are increasingly transferring labor-intensive businesses to low-cost developing countries such as India.

6.1 MODERATING TRANS-BORDER COMMUNICATIONS AND TRANSACTIONS COSTS

As a result of globalization, businesses' supply networks and investments in new goods and services are altering rapidly. Because of developments in information technology and information systems, the ability to exchange and process information digitally is becoming increasingly important to the worldwide business goals of many U.S.-based firms.

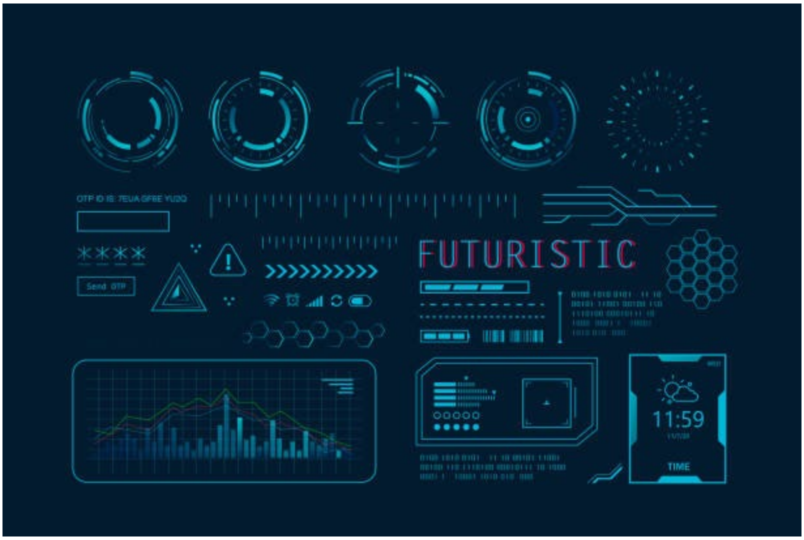


Figure 6.4: App user interface infographics elements.

Source: https://media.istockphoto.com/vectors/futuristic-hud-ui-for-app-user-interface-hud-and-infographic-elements-vector-id1175917028?k=20&m=1175917028&s=612x612&w=0&h=iGh1UWxKxhIe3Dp0yrfs2wf3p466mU6O-ZOQvG0MaZKU=

To function successfully, a global firm requires improved information technology and data systems all over the world. This is where their business can help. They are present in desktop and mobile computers, as well as hardware and software. By adopting these new technologies, businesses may better connect to worldwide information networks and fulfill their full economic potential. The Internet and Internet-based solutions promote globalization by making it easier than ever to communicate and share information throughout the world. Globalization has been further expedited by the technology and software that connects systems and people all over the world (Granato et al., 2014). Because of improvements in artificial intelligence, computer systems are increasingly capable of doing activities that were previously reserved for people. Language translation, decision-making, and speech recognition are examples of cognitive abilities. Once these abilities are integrated into a computer system, it is simple to grow globally in a variety of ways.

Businesses that install a computer system with visual perception, speech recognition, and decision-making skills may expand their operations without having to hire or teach new workers. As a consequence, both time and money are saved. The technology is designed to handle location-specific inquiries with minimal human error and language issues as a result of a comprehensive strategy and task analysis. When conducting business in places where English is not widely spoken, foreign language translation may be quite valuable. Because of modern information technology, "remote activities of multinational corporations may connect fast."

International communication is critical for every global business or industry. Mobile phones, networks, and personal computers are just a few instances of how modern information technology has aided in the expansion of globalization. As a result of these advancements, worldwide trade is now considerably more feasible and less time-consuming than it was previously. Employees may connect via email, phone conversations, and instant messages on mobile devices, allowing them to do their tasks more quickly and efficiently. Because of computer networks, multinational firms may now deliver timely services all across the world. Consider the following scenario: A consumer makes a request, which becomes public. Because of the great procedure, consumers are unaware that their case is being processed in another country. Businesses all across the world may now work without regard to time or location because of advances in information technology and systems (Grupp & Mogee, 2004). As a result, businesses can access a centralized information flow at any time and from any location, enabling them to digitally integrate every stage of their supply chain, from sales to manufacture to delivery.

Figure 6.5: Applications of a smartphone with business graphs and analytics.

Source: https://media.istockphoto.com/vectors/application-of-smartphone-with-business-graph-and-analytics-data-on-vector-id1307193193?k=20&m=1307193193&s=612x612&w=0&h=LvOn_5rid7nLvLfYRWNPsQyHL1K2UL-VRRsrv9ztyAGw=

The advancement of technology and business processes has aided globalization by improving worldwide corporate competitiveness. Organizations are understanding the significance of integrating their technology and information systems across national boundaries to compete in the global economy. Globalization is propelled by information technology and information systems, which enable businesses to provide goods and services to clients all over the world.

Technological innovation has pushed globalization even more. Technological advancement has assisted globalization. Businesses all across the world are increasing as economies of scale and the size of the break-even market grow. Technology advancements have reduced the cost of international travel and communication, making it simpler than ever to obtain raw materials and other inputs from anywhere around the globe. Because patent-protected technology is easier for firms to obtain and employ, there is less competition in the worldwide market (Gandini, 2011). The world's civilization is being influenced by digital technology. Because of the internet, there are no longer any geographical or temporal constraints in business. Transactions may now be conducted at any time of day or night from any location on the planet. A range of variables is there, including technological advancements, impact investment decisions.

Previously, only industrialized countries could research and manufacture cutting-edge technologies. Bringing together high-tech businesses with low-wage labor in underdeveloped nations is now a simple and uncomplicated procedure. The transfer of labor-intensive activities from established nations such as the United States and Europe to emerging economies such as India has increased.

6.2 ALLOWING BUSINESSES TO CONNECT WITH CUSTOMERS AND SUPPLIERS IN ANY COUNTRY

Even though there is still much work to be done, business is entering a new era of active adoption. Although it is still relatively new, the emphasis on "Digital" has grown, and top firms are now actively investing to develop the necessary capabilities and skills. There are most likely two explanations for this: These technologies are referred to as "digital" as a group, even though the underlying technology and emphasis on analytics and mobility are not. There have been periodic spurts of activity and testing over the years. Greater benefits may be obtained using Digital's context-rich framework than with individual technologies used in isolation (Ferrari et al., 2015). The convergence of diverse firms under a single roof by early adopters increases digital's significance and drives more investment in all digital technologies. According to current thought, technologies such as data analytics, mobility, the cloud, and collaboration will have a big influence on shared service management. Although digital service providers have a large market, solving the problem will be tough.

Figure 6.6: Digital marketing concept.

Source: https://media.istockphoto.com/photos/digital-marketing-concept-on-line-advertisement-picture-id1284549946?k=20&m=1284549946&s=612x612&w=0&h=VVGNI_vARpvpqo2Md_xsfcSiotjVVjzisV75dF15T-0=

Businesses are researching or pursuing digital transformations for several reasons, including rising consumer expectations and the need to adapt swiftly to emerging disruptive business models and capabilities. Businesses understand. They are fully aware of the need of utilizing the potential of digital technology to boost income. They value a more iterative approach and a quicker time to market, as well as the need of being significantly more agile. “Improving IT Simplification to Accelerate Digital Transformation” (BCG report, April 2016) Businesses are understanding that in today’s technologically advanced world, they need a strong network of partners to flourish. Companies in the technology and telecommunications industries, in particular, have the power to assist their corporate clients, but only if they can understand their needs and objectives and then design digital solutions to their specific needs.

According to BCG’s results, 300 digital providers and their corporate clients in Germany and the United States were polled on digital transformations and their success determinants. Respondents believe that if digital providers can solve these problems, they can make a difference and help their businesses grow.

6.3 MAKE YOURSELVES TRUE DIGITAL ALLIES

Partnerships may account for one of the most important gaps between digital providers and their clients. According to 60 percent of consumers and suppliers, cooperation is extremely or very vital to another 25-30%. There is now a gulf. When asked if they regarded digital providers as vendors or partners in digital transformations, more than two-thirds of suppliers see themselves as suppliers, whereas 60% of customers answered “partner.” (Ferguson & Zhang, 2002)

If you provide digital services, you have a clear opportunity and need to strengthen your client relationships. Customers have requested compliance. Providers must examine the financial benefits of integrated solutions in addition to the technical features of their goods and services. Customers are looking for cloud-based hardware and software vendors, as well as telecommunications companies that provide crucial digital transformation partners. Customers should be considered when determining the worth of the partnership’s actual assets.

When asked about acquiring new digital solutions, purchasers rated the relevance of present relationships as extremely low. The supplier’s ability to integrate security solutions with the company’s day-to-day business activities came in second and third place. Customers have stated that if their current provider does not match their demands, they are prepared to move to a new one. According to a recent poll, customers are demanding proof of value before expanding an existing connection due to digital disruption (Floros et al., 2010).

Suppliers must refocus on the business issues that corporate clients face and how technology may assist them to overcome these constraints. Because of the integration-friendly design of digital suppliers' goods, standardization is becoming increasingly important. Suppliers should do a better job of ensuring that their solutions meet the expectations of their consumers. By expanding their visibility outside of the CIO group, suppliers may make their case and get the support of senior corporate and business unit management. Even though change is frequently pushed from the top, more than 40% of corporate clients said that their business units were involved in the selection of digital solution providers.

Figure 6.7: Futuristic city wire frame.

Source: https://media.istockphoto.com/photos/futuristic-city-vr-wire-frame-with-group-of-people-picture-id1299624974?k=20&m=1299624974&s=612x612&w=0&h=CxreGoIzOnnZGYYCvnI-jprFRTA9wKOcunmtjBh_y00=

The findings of surveys conducted in the United States and Germany show considerable differences in sentiments. Customers in Germany, for example, are more worried about the digital transformation ability of their partners and suppliers than customers in the United States. In general, the outcomes are the same. Globally, digital transformation is becoming increasingly crucial. It is advantageous for technology (hardware and software) firms to be able to provide the same goods and services in several markets (Bernardes & Albuquerque, 2003). Telecommunications firms may establish long-term ties with German customers by offering connection services. As a result of these upheavals, new alliances between telecom and technology businesses may be conceivable along newly established value chains.

The first step is to dip your toes into the water.

Enterprises value digital changes. Three goals drive a company's shift: quicker procedures, greater money, and increased efficiency. According to our poll, over two-thirds of respondents desired to increase their revenue and productivity as the main aim of their change.

Customer benefits, such as enhanced customer experiences and data collection, are becoming more generally recognized by digital suppliers, who believe they can better convey the relationship between new technology-based capabilities and higher profitability. Customers must first be persuaded that their purchases are worthwhile. Suppliers must guarantee that their services directly meet the needs of customers going through digital changes and that consumers are aware of this fact (Breschi & Catalini, 2010). Suppliers can then discuss the technological, mechanical, and economic implications of their goods. However, as previously said, suppliers seeking to form a solid partnership should not go to the second step while the client is still in the first stage and asking specific questions.

In the digital market, vendors who target business clients rather than IT buyers will have an edge. According to BCG research, it is typical for businesses to feel restricted from using consumer data for third-party marketing, anonymous or non-anonymous purposes, even when they have their consumers' agreement. For further details, see BCG Research's October 2016 report "Bridging the Trust Gap: How Big Data Is Doomed to Fail." As a CMO, you are more likely than a CIO to profit from this knowledge.

Make an immediate impact.

Cost is a concern for enterprises. In response to an open-ended question, more than a quarter of respondents stated that the single most significant barrier to change is cost. Comprehensive improvements might take years and cost a lot of money. How can organizations strike a balance between the urge to alter models and processes and the equally important need to manage their operations during the transformation? How can they prevent a multi-year program that only brings benefits in the end? "Generating Value While Transforming Insurers' Legacy Technology." Each corporate customer is most likely at a different stage of its digital transformation journey, ranging from just getting started to have a transformation program in place, which affects their immediate objectives.

Digital vendors, for example, who are working with clients in the early stages of transition should prioritize short-term activities to aid the transformation process. Increased productivity and cost savings as a result of more effective process automation are unmistakable markers of success. Quick wins are technological solutions that enable the rapid delivery of new corporate client services, such as consumer data collecting (Bengisu & Nekhili, 2006). Customers may assess outcomes in a variety of ways, including enhanced cross-selling and retention rates, as well as conversion rates that lead to increased customer satisfaction and advocacy.

6.4 DIGITAL SKILLS SHOULD BE HIGHLY VALUED

Companies may recognize the need for digital skills, but they frequently underestimate their performance-enhancing impact. Only around one-third of businesses evaluated digital transformation accelerators like talent acquisition as extremely important.

According to BCG consumer marketing research, even as digital investment grows, digital skill levels remain low, and firms face the most acute shortages in critical skills such as mobile, video, testing, partner management, and organizational capabilities. The value of these skills will only rise in the coming years.

The Digital Marketing Talent Revolution

Talent and other digital accelerators are becoming increasingly important to digital providers. Poor HR quality was cited as the most significant impediment to digital transformation by 17% of suppliers (Bell & Lederman, 2003). Suppliers can use their talent on behalf of their corporate clients, but as partners, they must also help their clients recognize and close the talent gap. (If they do not, corporations who buy expensive technology that fail due to a lack of competent workers may blame their suppliers.)

6.4.1 Don't Over-Engineer

On the one hand, businesses looking to digitize their operations have a wealth of possibilities, including off-the-shelf items, cloud-based services such as software or platform as a service, bespoke solutions built and installed by the provider, and an ecosystem of suppliers. It is perhaps unsurprising that digital vendors feel their personalized solutions are the most relevant Customers, on the other hand, want ready-to-use solutions, and there is a major trend toward standardized cloud solutions among enterprises looking to streamline their procedures and operations (Foest et al., 2006). Salesforce.com and other new entrants with cloud-based models have taken advantage of this opportunity to quickly position themselves as significant players.

Corporate customers want both off-the-shelf items and help integrate and customize those solutions for their specific needs. This is distinct from a solution suited to a corporate customer's demands. Nonetheless, digital providers that have specialized in the latter will be forced to adopt the former as cloud-based solutions gain popularity, owing to the compelling argument that businesses receive a high return on investment.

A midsize retailer, for example, may cut its baseline IT expenditures by 47 percent by replicating its existing IT stack in the cloud, freeing up profits that may be reinvested in the business. According to a 2016 BCG poll of 750 CIOs from midsize US organizations, 65 percent aim to move workloads to the cloud by 2017.

"Can Your Network Deliver the Potential of the Cloud?" Standard cloud-based solutions' increasing flexibility will accelerate their adoption, and suppliers who remain committed to their customized solutions will miss out on an opportunity to combine cost-effective solutions with efficient implementation—an important lever for streamlining technology and generating immediate impact on the bottom line (Borup et al., 2006).

Figure 6.8: Adding modifications to latest code.

Source: https://media.istockphoto.com/photos/adding-modifications-to-their-latest-code-picture-id935964092?k=20&m=935964092&s=612x612&w=0&h=u-FaJcliQUADAhVEr238omVGMMuaN3_JYY1PMBYlMPw=

There is an opportunity, but do digital service providers have the necessary skills to succeed? Today's digital suppliers adequately meet their clients' transformation needs, but there is an opportunity for improvement. More than 80% of consumers feel their suppliers meet their expectations at least somewhat, whereas just 35% believe their needs are satisfied totally or nearly entirely.

Concurrently, corporate clients are looking for partners that can have an immediate impact as they navigate the change process. The digital suppliers that can show business and IT customers that they are focused on value, understand the complexities of digital transformations, can help fund the journey with early wins, and can expedite the transformation agenda with integrated, ready-to-use digital solutions will win (Dhillon et al., 2017).

Technology has the potential to have a significant influence on the supply chain. There is no dispute about the advantage, whether it increases efficiency or decreases expenses. The issue is that technology is consistently underutilized both within and outside. Technology may assist improve buyer-supplier relationships in addition to enhancing internal procedures.

Supplier relationships are frequently devalued because buy-side firms fail to see how a balanced relationship with their suppliers may benefit the purchasing business – it is a collaborative effort. Procurement directors must establish positive connections with their suppliers to deliver high-quality services and efficient operations. Suppliers who trust and respect the buyer are more likely to prioritize the consumer.

Finding the correct supplier is the first step in every successful business collaboration, but doing it manually takes time and raises the likelihood of missing vital facts. Technology simplifies the process and instantly determines the appropriate match with a few easy clicks (Doi, 2006). Once the sell-side is in place, the following stage is to establish the necessary communication channels and payment systems, which may be performed via a variety of technological methods.

Businesses looking to increase their supplier relationships might consider utilizing the four technologies listed below:

E-Sourcing

Finding a suitable supplier may be difficult if the necessary technologies are not in place. Businesses may quickly compare suppliers using e-sourcing technology, making the selection process more efficient and effective. When selecting a supplier, customers no longer need to rely on the seller's word or previous contracts. Instead, all pertinent information is gathered in a single location. This form of technology assists procurement executives in comparing and selecting the best vendor (Cao et al., 2006).

Transmission Routes

Inconsistent and unconnected communication between consumers and suppliers might lead to unnecessary tension between the two sides. Opening up new lines of communication can help to develop openness and avoid misunderstandings. Communication technologies that allow buyers and sellers to connect in real time make the transaction process more fluid and successful.

Settlement Capacity

Technology can help to speed up and simplify the payment process by keeping track of invoices and saving payment data. Payment technology may be used by businesses to examine rates and fees in advance, establishing confidence between business partners. Buyers and sellers can verify invoices instead of seeking receipts or transaction details, reducing the need for further communication.

Initiative for Transparency

Trust is the cornerstone of every successful partnership, but it can be difficult to develop in a buy-sell deal due to the diverse goals of each organization. Operational transparency, such as dual-sided pay systems, relieves pressure and provides real-time information. These automated systems ease ordinary procedures, relieving sellers and purchasers of stress and offering a window-like channel for both sides (Chadwick et al., 2011). Transparency creates equal collaboration and eliminates reliance on a single person in a transaction.

Figure 6.9: Global connection lines.

Source: https://media.istockphoto.com/photos/global-connection-lines-data-exchange-pandemic-computer-virus-picture-id1211443622?k=20&m=1211443622&s=612x612&w=0&h=fmCSNRN3rP_2FaYFgP_sRYFtDH3lOdf_6t6VeyebkeE=

Significant adjustments are necessary for the areas of sourcing, communication, payment systems, and buyer-seller operational transparency. Procurement executives must assess their present procedures and explore adding new technological alternatives. Technology not only improves procurement efficiency but also enables the connections required to sustain a successful supply chain (Zhang et al., 2018)..

6.5 ENHANCING CONNECTIVITY, FINANCIAL INCLUSION, ACCESS TO TRADE AND PUBLIC SERVICES

The world has profoundly transformed as a result of digital technology. As a consequence of technical improvements over the last two decades, a wide range of commercial and government services have become more accessible to the general people.

Because of the introduction of virtual classrooms and online learning, students who would not otherwise be able to attend school now have additional options. It is feasible that technological improvements will have a positive impact on global civilization. Those who are unable to use technology or the internet, on the other hand, fall farther behind in this new digital era. The gender digital divide refers to how real-world gender inequities are replicated online (Zeldin et al., 2008). As a result, men, boys, and girls have quite varying levels of digital adoption, accessibility, and utility. Due to heightened instability and violence, the COVID-19 outbreak has exacerbated the gender digital divide in some areas.

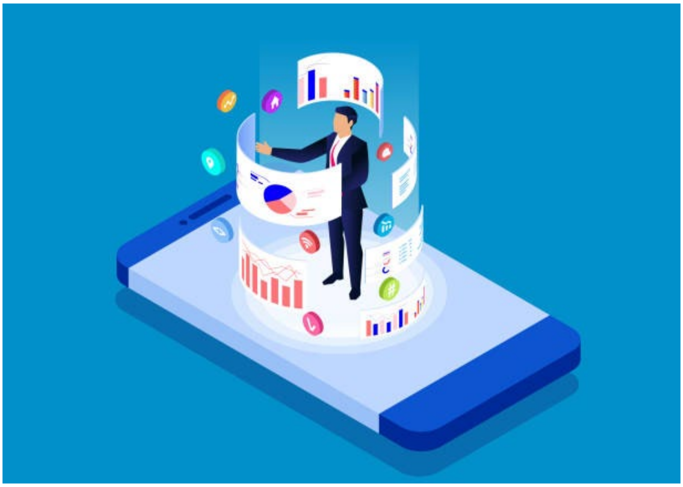


Figure 6.10: Smartphone online data analysis.

Source: https://media.istockphoto.com/vectors/smartphone-online-data-analysis-and-management-tool-data-analysis-vector-id1269463789?k=20&m=1269463789&s=612x612&w=0&h=wFi5yy6BuYEuy1xJUqGwrZgSsMQU22NlZyTLf4Jmwos=

Bank institutions and a growing number of non-financial groups are attempting to deliver financial services to disadvantaged and financially excluded areas using digital strategies that have been present for years to reach billions of new consumers. More than 80 nations already provide mobile-based digital banking services. Some of these companies have a sizable market share. Many low-income people currently use mobile phones or other digital technologies to gain access to formal financial services including payments, transfers, savings, credit, insurance, and even stocks. As new technologies develop, the situation just worsens (Wu et al., 2019).

It is the use of low-cost digital tools to provide a wide range of formal financial services to underserved and financially excluded places at a fair cost for customers and a sustainable cost for providers.

Regardless of how much their years of experience assist digital financial service providers, new services come with a variety of risks.

- Use of cutting-edge technology in the development of non-financial enterprises
- Financing institutions and other parties participating in unique legal structures such as agent networks and other types of outsourced services (Woolgar & Lezaun, 2013).
- Deposits, on the other hand, are subject to more stringent rules.
- Charges that ignorant or inexperienced clients were not expecting or even aware of; and
- The usage of new data types and purposes, which creates new privacy and data security concerns

The most significant features of digital financial inclusion are as follows:

- Consumers can store value in digital transactional platforms by using devices that send and receive transaction data and connect to a bank or non-bank approved for electronic value storage.
- Mobile phones and payment cards are two examples of consumer gadgets that communicate with a digital device such as a POS terminal(Antal & Grønli, 2003).
- Retail agents can exchange cash for electronically stored value (“cash-in”) using a digital device connected to the communications infrastructure, and consumers can swap stored value for cash (“cash-out”).

- Banks and non-banks alike may use the digital transactional platform in the future to provide a broader variety of financial services to individuals who are now underserved or otherwise financially excluded.
- Data from digital sources is commonly incorporated into risk management procedures at these companies.

Figure 6.11: Social networking service.

Source: https://media.istockphoto.com/photos/social-networking-service-concept-streaming-video-video-library-picture-id1194783078?k=20&m=1194783078&s=612x612&w=0&h=uRAiG8wuV31xVMs1R10T3JiPAgve9Dx-CEzY8KUj14hY=

2.5 billion Individuals who do not have access to traditional financial services may see their lives alter as a result of digital financial services. Among the many advantages of digital financial inclusion for the poor and financially disadvantaged are the following:

Payments, transfers, savings, credit, insurance, and investments are examples of organized financial services. Clients often shift to account-based services as they gain expertise with and trust in a digital transactional platform. Government-to-person payments, such as conditional cash transfers that allow for digital stored-value accounts, may help the financially excluded acquire access to the financial system (Wang, 2009).

Why Customers may trade extremely tiny amounts locally because digital transactional systems offer reduced prices, which benefits both the provider and the buyer. This assists them in managing their very variable income and expenses.

- The payment, transfer, and value storage services integrated into the digital transaction platform, as well as the data gathered via it, enable the creation of new financial services tailored to individual clients' wants and financial circumstances.
- Lowering the expenses associated with informal providers and cash-based transactions, as well as lowering the risks of loss, theft, and other financial crimes.
- It may contribute to economic empowerment by encouraging wealth accumulation and economic participation, particularly among women (Wynne, 2007).

The same poor, disadvantaged, and financially excluded clients who benefit from digital financial inclusion face risks. These dangers include, but are not limited to:

- Customers who may be harmed or mistreated because of their unfamiliarity with the providers, commodities, and services.

Why Consumer protection regulations applicable to banks and other traditional financial institutions do not apply to new service providers' agent-related risks?

- Risks connected with digital technology include service disruptions, data loss, including the loss of payment instructions (for example, as a consequence of lost messages), and the chance of a privacy or security breach as a result of digital data transfer and storage.

Given the widespread acceptance of digital financial services by consumers, these risks may not outweigh the benefits of having access to money in general. Nonetheless, sufficient regulation and oversight are urgently required (Woellert et al., 2011).

The most significant regulatory problems raised by digital financial inclusion include agents, anti-money laundering and counter-terrorism (AML/CFT) requirements, e-money regulation, consumer protection, payment system regulation, and competition. Many of these issues fall within the purview of many agencies, necessitating effective collaboration and communication between them.

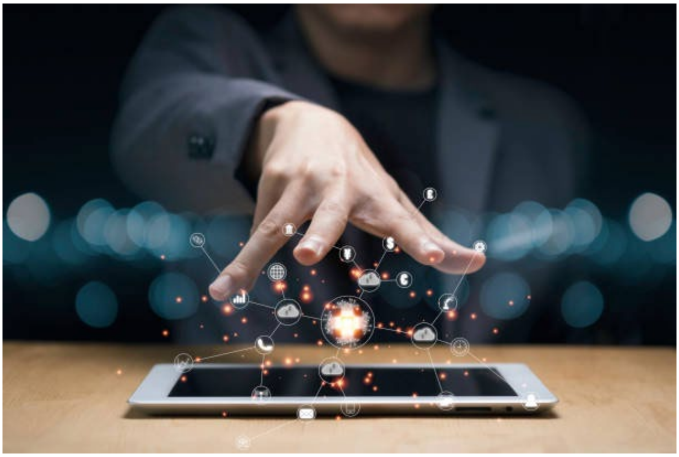


Figure 6.12: Hand create artificial intelligence.

Source: https://media.istockphoto.com/photos/businessman-hand-create-artificial-intelligence-for-technology-and-picture-id1221155808?k=20&m=1221155808&s=612x612&w=0&h=FfAusgEoLa_alJpjPkOFDcB70Qbn-oUd6k-kdn3tmDqg=

Unlike traditional methods of providing retail financial services, digital financial inclusion models being explored in many countries throughout the world incorporate new market participants and assign duties and risks (both new and well-known) (both new and well-known). The great majority, if not all, proposals for fostering digital financial inclusion are fraught with danger. When mobile network operators (MNOs) are used, whether as e-money issuers or as a conduit for a bank or another provider, certain potential problems arise that do not exist in systems that do not use MNOs. The construction of a suitable digital transactional platform entails several difficulties (Whitcombe et al., 2014). Aside from the payments, transfers, and value storage services presently provided by the digital transactional platform, the supply of new financial services is fraught with danger.

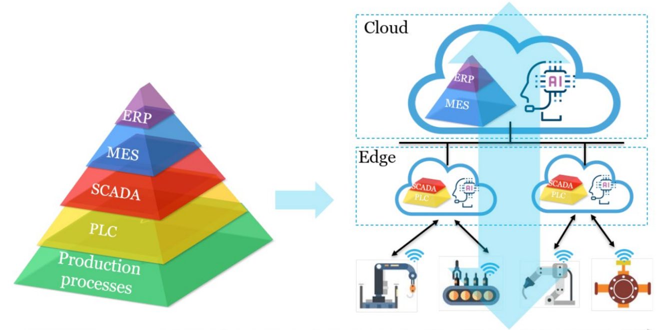
6.6 REVOLUTIONIZING INNOVATION AND DEVELOPMENT OF NEW PRODUCTS AND PROCESSES

Digital innovation is the application of digital technology to the presentation of company problems or operations.

It is better to think of the process in terms of waves, with each wave being powered by new technological breakthroughs.

Previous waves were driven by the introduction of Web 2.0, sophisticated mobile devices, and quicker internet connectivity. Wearables, smart home apps, and IoT are just a few examples of how Web 3.0 is already transforming the way we engage with technology and live our lives (Verbeek et al., 2002).

As a result of the pandemic, many consumer journeys have now started on the internet. To be successful in today's digital climate, every firm must now consider itself a technology company. Businesses that take advantage of the possibilities to sell digital goods and use predictive data and analytics to better understand customer behavior and internal performance may increase revenues, save expenses, and even generate new income streams.



Pyramid Architecture of traditional industrial automation system

Internet of things, cloud, and edge computing enabled industrial automation system

Figure 6.13: An illustration of the digital transformation in industrial automation system. The traditional industrial automation system adopts a pyramid architecture where the production process, programmable logic controller (PLC), supervisory control and data acquisition (SCADA), manufacturing execution system (MES), and enterprise resource planning (ERP) layers are strictly hierarchical. By leveraging IoT and cloud computing, the connectivity and computation capabilities are enhanced, and artificial intelligence derived from data is distributed across the full stack of the system.

Source: Liu Y, Ni Z, Karlsson M, Gong S. Methodology for Digital Transformation with Internet of Things and Cloud Computing: A Practical Guideline for Innovation in Small- and Medium-Sized Enterprises. Sensors. 2021; 21(16):5355. https://doi.org/10.3390/s21165355

As a result of digital innovation, the corporate environment is changing dramatically. There are three possible ways to make money:

- Traditional business processes may benefit from the application of digital technologies.
- Using digital technology, you can alter present corporate structures and procedures.
- Digital technology has the potential to enable the development of whole new engagement and economic models (Adamovich et al., 2017).

6.7 WHY IS IT CRITICAL FOR YOUR FIRM TO PRIORITIZE DIGITAL INNOVATION?

Businesses risk being overrun by more sophisticated competitors if they ignore breakthrough technology. Astute business executives must always seek ways in which new technological advances may help companies stay relevant and deliver value.

Innovative businesses can benefit from the following:

- A competitive edge
- Technological solutions that boost ROI and sales success.
- Increased productivity and optimized operations have emerged from automated and integrated digital solutions.

Digital innovation is critical for every company's long-term success. Some of the explanations stated are as follows:

Data underpins every part of our existence.

Concentrate on digital innovation powered by data and analytics. Businesses will have unparalleled access to client data as the world gets more connected. Corporate leaders that place a high value on digital innovation may be able to derive significant customer insights from this data (Terrones, 2003).

Clientele with greater expectations

Customers now have more alternatives than they have ever had before. When it comes to a straightforward and clear user experience, customers have high expectations. This includes all aspects of the application's usability and internal staff interactions. It is vital to prioritize digital innovation in your business to guarantee that you are continually employing technology to give an amazing experience to your clients.

Increasing employee productivity

Because of developments in digital innovation, organizations may now use automation to increase worker productivity. By automating regular activities in human resources departments like payroll and onboarding, staff may have more time to tackle other obligations.

Many firms' digital transformations have been expedited by remote workers. Teams will have to operate remotely in 2020-21 to maintain operational continuity throughout the various worldwide lockdowns (Sismondo, 2018). Following the declaration of pandemic COVID-19, working from home became mandatory or encouraged in 88 percent of enterprises worldwide.

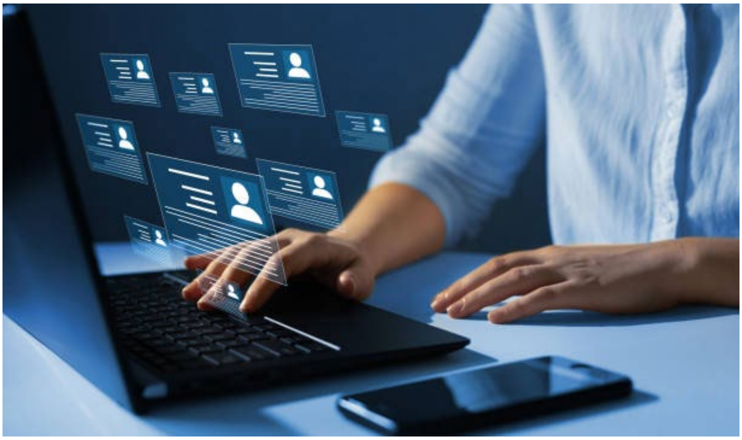


Figure 6.14: Human resource manager.

Source: https://media.istockphoto.com/photos/human-resource-manager-checks-the-cv-online-to-choose-the-perfect-picture-id1352650187?k=20&m=1352650187&s=612x612&w=0&h=EtEfoDGYV3XxSMVHrWKFbATV8Lsny-ni3Xq7Ww9S6T44=

Businesses that transitioned to a digital work paradigm quickly discovered benefits such as global workforce access and greater productivity (77 percent of remote workers reported being more productive while working from home), according to preliminary research (77 percent of remote workers report that they are more productive working from home).

Safety is more important than ever.

Today's organizations face greater digital hazards than at any other moment in history. Businesses are increasingly depending on cloud computing services, necessitating the use of cutting-edge security measures (90 percent of businesses currently use cloud computing for part of their services). Companies that do not keep up with the newest security improvements risk falling victim to increasingly skilled thieves(Alexander et al., 2006).

6.8 IS THERE A RISK ASSOCIATED WITH NEW TECHNOLOGY?

Promoting digital innovation has considerable risks.

One well-known example is Lidl's botched attempt to implement an ERP system across the board. Decisions not to modify current business procedures and software before recognizing that a customized version was too expensive to develop resulted in losses of approximately €500 million. Following that, Lidl reverted to its old technique, demonstrating how much harm a poor digital strategy can cause.

What are the key takeaways from this? Others blame the new software, while others blame Lidl's failure to meet the new program's standards on the company's design. In any event, the example offers an illustration of what may go wrong if a digital strategy is not executed after rigorous, strategic planning (Banerjee & Williams, 2013).

Ignoring the rapid improvements in digital technology is also risky.

All firms will have adopted digital transformation by 2025. According to reports, the great majority of CEOs and senior executives have a digital company plan in place. According to the most recent McKinsey research, incumbents are not innovating because they are afraid of losing their primary source of revenue. This is a dangerous approach in an ever-changing technological world.

Kodak is a prime example of a company that lost its potential by neglecting to innovate. Because they were aware of the approaching digital revolution, they devised a plan. The company invented the first digital camera and promoted several of its workers to positions of leadership.

However, the company's stubbornness to abandon its fundamental business concept eventually led to its demise. Kodak felt the film too important to risk losing its greatest market, and by 1996, the business had dwindled from a $30 billion behemoth to a hardly discernible presence (Shannon et al., 2010). Following a bankruptcy filing in 2012, the company reopened in 2013 to service commercial clients.

6.9 WHAT DEFINES DIGITAL INNOVATION?

Despite the hurdles in embracing digital advancements, several industry leaders have made the leap and effectively integrated digital technology into their product offerings.

M2M communication is ushering in a new era of "predictive maintenance," which is expected to be worth $12.3 billion by 2025. When repairs are required, data from sensors incorporated into the machinery can be forwarded to a service specialist for an examination. Because only damaged or malfunctioning components are evaluated, time is saved and the chance of an accident is reduced. Organizations benefit from lower maintenance expenses and the avoidance of mechanical concerns (Suryanarayana et al., 2001). The oil and gas industry is a great example. Many pipeline operators are cutting labor costs and saving time by using sensors instead of human inspections, while simultaneously boosting operational safety.

Figure 6.15: Green energy car design diverse team of automotive engineers.

Source: https://media.istockphoto.com/photos/green-energy-car-design-diverse-team-of-automotive-enginers-using-picture-id1367303369?k=20&m=1367303369&s=612x612&w=0&h=kFMxV-wyOIjjpOWSMKBg-8LM67AZvqcI-67DgTKEhHY=

Marketers are experimenting with new ways to communicate with customers. Customers are increasingly connecting with businesses before purchasing a variety of media. Marketers may transform these touch points into extremely efficient acquisition channels with the correct digital strategy. Starbucks is a great example of this method. The company introduced a mobile app for placing orders and making payments in 2009. Customers may use this app to order and pay for food and beverages from restaurants. In 2020, mobile devices will account for a record 22 percent of all transactions, demonstrating the program's tremendous performance(Badgujar et al., 2008). The true worth of the global coffee company, on the other hand, is found in the data generated by the software. Marketing messages and promotions may be personalized to each customer based on their purchasing habits.

Fortune contributor Kyle Wong lauded Domino's successful digital transition as a "case study on how digital transformation delivers an economic advantage." Customers will be able to place pizza orders using emoticons and speech recognition technology via Slack, Facebook Messenger, Twitter, and Alexa by 2020. During the COVID-19 crisis, this was a wise option, as online purchases will account for over 75% of all consumer transactions by 2020.

6.9.1 What Actions Can You Take To Ensure That Your Business Is Founded On Digital Innovation?

Even if it isn't always clear-cut, there are a few simple steps you can take to get started with a digital innovation plan.

Many multinational corporations have set up internal innovation laboratories or accelerators to allow employee teams to test new concepts and procedures without disrupting the overall business (Bøe et al., 2011). This may also be done on a smaller scale by allowing a small group of employees to experiment with new ideas.

Staff

Begin by allowing three to five motivated workers to test out new technical solutions to your company's difficulties.

Process

Create an agile experimentation plan to keep track of work and collect feedback. If you don't want to disrupt your usual job obligations, make sure this is done separately.

Technology

Implementing the most recent technological breakthroughs is the greatest method to satisfy all of your company's expectations. In other circumstances, this might include managing teams, collaborating online, or tracking a product's whole life cycle.

Review

Create a system for tracking short-term achievements and failures. You'll be able to make an educated selection about which classes to continue taking.

CHAPTER 7

PROPRIETARY SOFTWARE VERSUS OPEN-SOURCE

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7.1 DEFINITION OF PROPRIETARY AND OPEN SOURCE SOFTWARE

Any copyrighted software that has restrictions on its use, distribution, and/or modification imposed by its publisher, distributor, or inventor is considered Proprietary software. Proprietary software can be used by end users or organizations, but only within certain parameters, and it remains the property of the author or owner of the program. Commercial software and closed-source software can be used interchangeably with proprietary software (Swierstra & Rip, 2007).

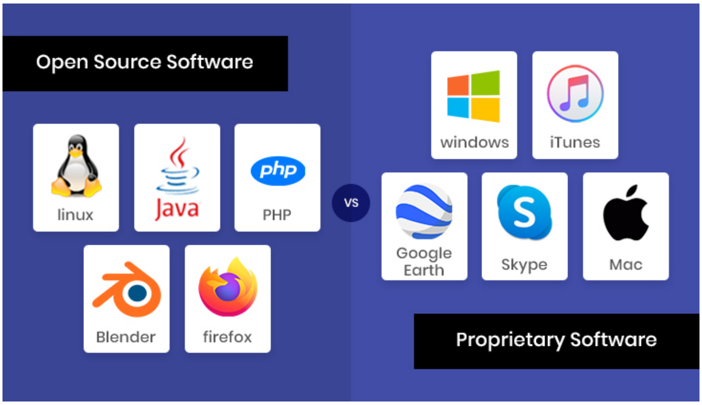

Figure 7.1: Proprietary software versus open-source.

Source: https://www.techasoft.com/blog/2020/07/1594806112.jpg

Commercial software is widely used in the software industry to refer to proprietary software that can only be purchased from the developer or creator. The majority of proprietary software subscribers and end users do not have access to the source code. It is not permissible to relicense, duplicate, or sell the product; nevertheless, a license or the product can be acquired outright. The majority of software licensed under intellectual property laws is created by an independent software developer (ISV) (ISV). Any limits or duties that the software's distributor or author may have are detailed in EULAs, TOS, and any other appropriate use agreement. Before installing or using the program, the user or organization must agree to the conditions of the agreement. The software vendor or developer can initiate a lawsuit against the end user or organization that violated the EULA or TOS. Users and other developers have unfettered access to the source code of open-source applications, allowing them to use or change them.

In contrast to proprietary software, open-source software is created and distributed by the broader public. Because open-source software is free and unfettered, anybody and everyone can use it. Any updates or upgrades must have access to the program's source code(Bernardes & e Albuquerque, 2003). Depending on your license agreement, you may be obliged to use a different name or version number for any later editions of the product. The program may be able to operate on the most recent operating system in some instances. Because they integrate the open source philosophy, many open source software license agreements are well-known and commonly used. These open source licensing agreements include the following terms:

The open-source community has had a significant impact on the commercial software development business. Developers are using new open source tools to aid in the early optimization and issue resolution of open source code. The term "open source technology" refers to more than only software development tools. The open source community has many more well-known pieces of software. The software is created by Red Hat. This open source software platform offers a number of productivity solutions in a corporate context.

7.2 TYPES OF PROPRIETARY SOFTWARE

7.2.1 Microsoft Windows

Figure 7.2: Microsoft Windows.

Source: https://media.istockphoto.com/photos/windows-8-start-screen-angled-picture-id458114779?k=20&m=458114779&s=612x612&w=0&h=3451_n3h-8bqIFu22GLUitbzUL0xb5R1jANnORe-eGPk=

Microsoft is in charge of creating and disseminating a wide range of Windows-branded graphical operating systems. For each family, there is a certain subject matter that they specialize in. Windows NT and Windows IoT are two of the current Windows generations. Windows Server and Windows Embedded Compact are both subfamilies of the Windows family (Windows CE). Because to the discontinuation of these platforms, Microsoft no longer offers any kind of support for them.

When Microsoft released Windows for MS-DOS on November 20, 1985, they were responding to the rising demand for graphical user interfaces (GUIs). In order to be compatible with MS-DOS, Windows was created. With the introduction of the Lisa and the Macintosh, Apple began to view Windows as an unfair competitor to their GUI innovation. In 1993, a settlement was reached that favored Microsoft in this case. Most personal computers are still running Windows, despite the fact that other operating systems have come and gone. Microsoft confirmed in 2014 that it has lost the majority of the operating system market to Android as a result of the rapid rise in the sales of Android devices. Only a quarter of Android phones were purchased in 2014, compared to the amount of Windows phones. StatCounter estimates that Windows will hold a 75 percent or more share of the desktop and laptop computer markets in April 2022 (Small, & Klavans, 2014). It was launched in July of that year and is the most recent version of Windows for desktops and tablets as of October of that year. Windows 11 build 21H2 is the most recent version of Windows for embedded devices. Windows Server 2022, version 21H2, was launched lately and is the most current server edition. Both the Xbox One and the Xbox Series X/S consoles use a modified version of Microsoft Window.

A number of trademarks have been registered by Microsoft, the company that created Windows, each of which designates a certain Windows operating system aimed at a specific segment of the computer industry. Each of these operating systems has a specific purpose in mind. Active work was taking on on the following Windows family as of 2014: When Microsoft initially released the original Windows NT, it was developed particularly for desktops and servers. This operating system family currently has three subgroups, all of which release new versions almost simultaneously and use the same kernel. Windows is the most widely used operating system for personal computers and tablets. It is possible to acquire the most recent version of Windows, which is called Windows 11. Among the main rivals of this family are Apple's macOS and iPadOS for personal computers, as well as Google's Android tablet operating system.

In the case of servers, Windows Server is the operating system that is employed. There is currently just one version of Windows Server available for purchase: 2022. It has opted for a more daring moniker than its client sister. The Linux operating system is the principal enemy of this family. In terms of market share, (compare the percentage of users of various operating systems) Windows PE is a stripped-down version of Windows that may be used as a live operating system for a variety of reasons, including troubleshooting, data recovery, and even installing Windows on bare-metal computers (primarily multiple PCs). You may get the latest version of Windows from the Microsoft website (particularly several PCs at once). Windows PE 10 is the most recent version, and the model number is 10 as well. If you don't meet the criteria to be considered a computer, you can use Windows CE, Microsoft's general-purpose operating system for any device that doesn't meet those criteria. Windows Embedded was previously known as Windows IoT. Eventually, Windows CE was renamed Windows Embedded Compact and merged with the Windows Compact brand (Rogers & Marres, 2000). Windows Embedded Compact, along with Windows Embedded Automotive and Windows Embedded Handheld, is now a sub-brand of Windows Compact. As the name implies, Windows Embedded Professional is a version of Windows Compact that targets embedded systems.

7.2.2 Adobe Flash Player

Figure 7.3: Adobe Flash Player.

Source https://t3.ftcdn.net/jpg/03/25/33/60/360_F_325336046_Mho819G-pTSPmIWK5aa33GKBB5JlPxpRA.jpg

Adobe Flash Player, a free download, may be used to view multimedia files, run Internet applications, and stream audio and video files created using the Adobe Flash platform. This software is known as Shockwave Flash in Internet Explorer, Firefox, and Chrome. It may be used as a standalone program or as a browser plug-in on devices that support it. After Macromedia purchased FutureWave in 1996, the FutureSplash Player was renamed the Macromedia Flash Player. FutureWave designed the player at the beginning. After acquiring Macromedia from its former owner, Adobe Systems began development on Flash Player in 2005. Users in China may obtain it through Zhongcheng, while enterprises outside of China can obtain it through Harman International in collaboration with Adobe. SWF files can be generated with Adobe Flash Professional, Adobe Flash Builder, or third-party tools like FlashDevelop, and Flash Player can play them back on your computer. Raster images, vector graphics, 3D graphics, and embedded audio and video may all be shown using Flash Player (Rao & Cheetham, 2001). Furthermore, it is compatible with ActionScript, an object-oriented programming language based on ECMAScript and comparable to JavaScript. For Windows 8 and later, Internet Explorer 11, Microsoft Edge Legacy, and Google Chrome all include a sandboxed version of the Adobe Flash plug-in.

Flash Player has historically had a large user base due to its use as an embedded format for GUI components, web games, and animations. Flash Player has been updated in just six weeks for more than 400 million of the more than 1 billion machines that are connected, according to Adobe in 2013. Flash Player, on the other hand, came under heightened scrutiny due to its functionality, the amount of power it used on mobile devices, the number of security flaws that were discovered in the program, and the fact that it was closed platform software. A letter written by Apple co-founder and CEO Steve Jobs has been made public, in which he slammed an application called Flash Player and explained why the company does not support Flash on iOS devices. Modern online standards, which make it simpler to fulfill some of Flash's use cases without the help of third-party plugins, have contributed to the platform's waning popularity. Adobe deprecated the platform as a direct result of this. Two days after Adobe stated that Flash Player will be deprecated at midnight on Dec. 31, 2020, the download link was taken down. After the 12th of January, 2021, the Flash Player (original international variations) versions newer than 32.0.0.371 will no longer be allowed to play Flash content (Breschi & Catalini, 2010). This warning message will be replaced with a static one instead of dynamically changing. In China, the application is maintained and may be found in a wide variety of corporate versions.

Runtime for Adobe Flash Player, which uses SWF files as input and displays results on a web browser. Adobe Flash Player, on the other hand, does not have any built-in facilities for editing SWF files during playback. ActionScript may be used to create software that can alter not only text and data, but also vector and raster images, sound, and video, all while it is operating. The user must provide the player permission to access other connected hardware devices, such as cameras and microphones. To support desktop and mobile apps on several platforms, Adobe Integrated Runtime (AIR) made internal use of Flash Player. A number of mobile operating systems, including iOS and Android, are supported by AIR, which may be deployed on a variety of platforms (Porada et al., 2013). The AIR runtime requires Flash apps to be created expressly for the AIR runtime in order to make use of extra features, including file-system integration, native client extensions, native window/screen integration and taskbar/dock interaction.

7.2.3 Adobe Photoshop

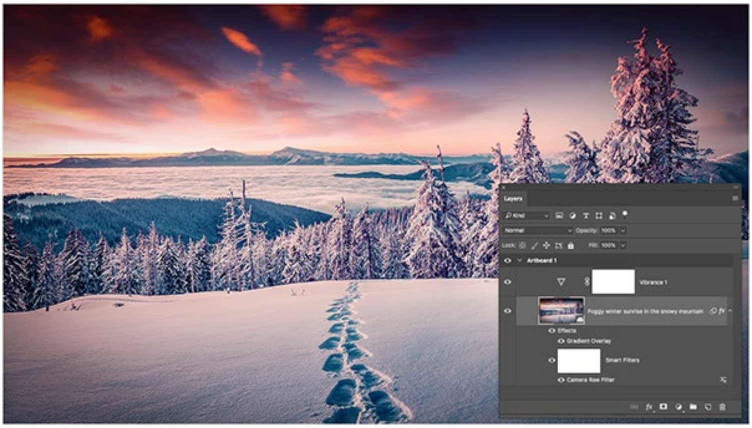

Figure 7.4: Adobe Photoshop.

Source: https://creativepro.com/wp-content/uploads/2016/11/Stock_Photoshop_008.png

Adobe Photoshop may be useful for raster image processing, graphic design, and digital art. Layering is used to add depth and adaptability to the design and editing processes, in addition to the sophisticated editing tools that can be used to create almost anything.

Thomas and John Knoll founded the firm in 1988. After a few years, John sold the program to Adobe Systems, who renamed it Photoshop. In the years since, it has become the industry standard for raster image processing. This application only supports Mac OS X and Windows; Linux is not supported.

Adobe Photoshop was founded in 1987 by two men named Thomas Knoll and John Knoll. Adobe Systems Inc. obtained the distribution rights in 1988. When Thomas was finishing his Ph.D. at the University of Michigan, he created the Display program on his Macintosh Plus computer. This program was used to display graphics on the screen. His brother John, who worked for Industrial Light & Magic, persuaded him to turn the program into a full-fledged application for the benefit of more users. Its collaboration with ImagePro resulted in the development of Photoshop, which they renamed after their predecessor (Pahlavan & Makela, 2002). We made a short-term agreement with Barneyscan, a scanner company, to distribute 200 copies of Photoshop alongside the slide scanners they sold.

Adobe's art director Russell Brown and Apple CEO Steve Wozniak were in attendance for John's performance. Adobe purchased the distribution license for the first time in 1988. Photoshop 1.0 was released for Macintosh computers on February 19, 1990. It was Photoshop's first public release. After only a few years, Photoshop had become the industry standard for editing digital photographs. Users can create and modify raster graphics on a variety of levels using Photoshop's features. These transparent "overlays" or "layers" can be used as filters or masks to alter the images stored in the layers beneath them. They are open and honest. If desired, alpha compositing, shadows, and other effects can be used. These layers can also use CMYK, RGB, Spot Color, Duotone, and Lap color spaces. It is the default extension for a work-in-progress file, and it is used by default. A "Photoshop Document" is abbreviated as a "PSD" (Photoshop Document). A PSD file cannot have a file size or pixels per inch greater than 2 GB. It is referred to as a type of document that may be created in Photoshop(Bengisu & Nekhili, 2006). PSB files may have a maximum height and width of 300,000 pixels, as well as a maximum length of around 4 exabytes. They're a large Photoshop document format.

7.2.4 Google Earth

Google Earth is a geobrowser that creates a three-dimensional representation of the Earth using topography, ocean bathymetry, satellite and aerial photographs, and other types of geographical data. Geobrowsers include

Earth browsers, virtual globes, and geobrowsers. Google Earth is frequently referred to as a “geographic browser” on Google’s website. In addition to ESRI’s World Wind and Explorer for ArcGIS, GeoFusion’s GeoPlayer is available. For individuals who do not wish to pay, Google Earth Pro includes a free desktop download alternative. Both the desktop edition of Google Earth and the mobile version of the program, Google Earth for Smartphone, are free. Despite its ease of use, the browser-based version lacks a number of features that may be valuable for educational purposes (it does not have to be installed on a desktop). Despite the fact that it can import kml files, search for places, and explore different regions using the Voyager, Earth for Web has numerous limitations that Google Earth Pro on the desktop does not have. You may also use Earth for Web to seek for specific locations (Otsuka & Kakeshita, 2002). This training course’s User Guide section discusses the workaround required, for example, to create a kml file in the browser-based version. In addition to its teaching value, the desktop edition of Google Earth Pro has a number of added capabilities. One of these is the ability to print and store higher-resolution photographs.

ArcGIS and MapInfo, two complex analytical GIS software, are both substantially more difficult to use than Google Earth, a web-based mapping program. Compatibility is with several operating systems, including Mac OS X, Ubuntu/Fedora, and Linux. Check that your machine fulfills the minimum system requirements before installing any software. To utilize Google Maps as an interactive map on a website, you must first download the Google Earth program. The ability to acquire turn-by-turn instructions was one of the first capabilities offered to Google Maps. It was only a matter of time before those who were interested in how Google Maps worked dug into the JavaScript code. After some time, Application Programming Interface (API) of Google Maps was made available to the general public, allowing developers to create unique user experiences (Nisbet et al., 2002). The Earth Engine, on the other hand, was designed to enable the general public to do geographical data study, which may incorporate satellite images. Thanks to this novel method, research that was previously only available to highly educated remote sensing specialists is now available to a far larger audience.

Google Maps and Earth Engine may be accessed using any of the major web browsers and computer operating systems. Google Maps and Google Earth Furthermore, Google Maps Platform is a service offered by the corporation to its consumers. The Google Maps platform enables users to access, modify, and integrate Google Maps data into their websites. The Google Maps Platform includes a variety of APIs in addition to the

Javascript API, the Maps Embed API, and Android and iOS SDKs for Android and iOS. Even if you don't know anything about programming, you can create rudimentary Google Maps. You can build and share user-friendly, personalized Google Maps by joining up for a free Google account, activating the My Maps feature, and then publishing your map online. You may use the URL supplied in the map to distribute or embed the map on another website. In addition, you will receive the HTML code required to embed the map on your own website. To use these maps, simply open them in your preferred web browser. By entering the URL of a web server-based file into the Google Maps search box, KML may be downloaded. These Google Maps, which may be easily made and shared, lack the functionality of Google Earth.

7.2.5 Skype

Figure 7.5: Skype.

Source: https://media.istockphoto.com/photos/colleagues-talk-online-from-their-homes-picture-id1226737565?k=20&m=1226737565&s=612x612&w=0&h=MABHzTRngpIMCZNuq8KArVaG7eCtOLUKMFZhXA5Iiy4=

Skype Technologies, a subsidiary of Microsoft, is in charge of and maintains the proprietary communications program Skype. VoIP (voice over Internet protocol), videoconferencing, and videotelephony are some of its most well-known uses. Other capabilities include sending and receiving instant messages, sending and receiving files, and making debit-based phone calls to landlines and mobile phones. Skype may be used on desktop computers, mobile phones, and even game consoles. Skype was the first of its sort, founded in August 2003 by Niklas Zennstrom, Janus Friis, and four other Estonian engineers. eBay paid $2.6 billion for Skype in September 2005. In September 2009, Silver Lake, Andreessen Horowitz, and the Canada Pension Plan Investment Board paid $1.9 billion for a 65 percent stake in Skype from eBay. The company's market value at the time of the transaction was $2.92 billion. When Microsoft paid $8.5 billion for Skype in May 2011, the corporation promptly replaced Windows Live Messenger with Skype.

According to 2011 data, Tallinn and Tartu accounted for around 44 percent of Estonia's entire employment. In the early stages of Skype's development, P2P and client-server technologies coexisted. Azure-based supernodes took over in May 2012, and by 2017 they were the sole means for the bulk of the service's users to access and utilize it. Skype has 100 million monthly users by the end of March 2020, with 40 million of them using it daily (Moore, 2013). Zoom outperformed Skype in terms of market share during the COVID-19 epidemic. Registered Skype users are identifiable by a unique ID number known as their Skype ID, in addition to their Skype username.

These individuals can utilize voice chat and instant messaging services since they have made accounts with Skype. Users can talk in pairs and engage in group conversations using an in-house created audio codec. Group conversations, emoticons, chat history storage, and the ability to edit previously delivered messages are all features of Skype's text chat program. Offline messages were removed from a test release of version 5 after a few weeks for unknown reasons. User profiles and online status indicators round out the list of accessible features.

You may dial a local Skype phone number in the following countries and regions: Australia, Belgium, Brazil, Chile, Colombia, Denmark, the Dominican Republic, Estonia, Finland, France, Germany, Hong Kong, Hungary, India, Ireland, Japan, Mexico, Nepal, New Zealand, Poland, Romania, the Netherlands, South Africa, South Korea, Sweden, Switzerland, Turkey, and South Africa. This function is most often known as Online Number, but it has also been referred to as SkypeIn. If you use Skype in any of these countries, calling local numbers costs no more than calling landlines inside that nation. Skype allows up to 25 people to use it at the same time for free conference calls, video chats, and screen sharing. On April 5, 2019, this restriction was raised to 50 users. Skype does not allow users to call emergency services(Bell & Lederman, 2003). This includes being unable to dial 112 in Europe, 911 in North America, 999 in the United Kingdom, or 100 in India and Nepal. As of December 2012, emergency calls in the United Kingdom, Australia, Denmark, and Finland were only partially operational. The Federal Communications Commission has determined that Skype does not qualify as an “interconnected VoIP service” under Section 255 of the Telecommunications Act (FCC). The United States National Emergency Number Association so strongly recommends a backup analog phone line for everyone who uses VoIP at home.

In 2019, Skype released a feature that allows users to utilize artificial intelligence techniques to completely automate the execution of video chat interface backdrop blur. While webcams frequently lack depth sensors, this is not a deterrent.

7.2.6 WinRAR

Eugene Roshal of win.rar GmbH developed the trial version of the file archiver program known as WinRAR for Windows. Apart from unpacking a wide range of archive file formats, it can also build RAR and ZIP archives, test them, and analyze them. The CRC32 or BLAKE2 checksums that are encoded in each compressed file using WinRAR can be used by the user to verify the authenticity of the archive. WinRAR can handle self-extracting, multi-part, and encrypted archives.

A Windows-specific application, WinRAR can only be used. “RAR for Android” is another Android application. “RAR” and “UNRAR” are command-line archive compression and decompression programs, as well as their macOS counterparts. Examples of software connected to this topic include Linux, FreeBSD, Windows CE, and MS-DOS.

The RAR file format and WinRAR have experienced a number of changes over the years. It is now called RAR4 and uses the same file extension as earlier iterations. Version 5.0 adds support for the RAR5 archive format, which is the successor to RAR4 and uses the same file extension as earlier iterations. Older WinRAR versions are the only way to access RAR5 archives while using a previous version of Windows before Vista. Prior to

WinRAR 5.0, the RAR5 archive format was not supported by WinRAR.

The maximum size of a dictionary has been increased to 1 GB thanks to changes in the RAR5 file format. The default compression directory size has increased from 4 MB to 32 MB in version 5 of the program. Compression ratios can often be improved by increasing the size of the compressed directory. When using the CBC mode, the AES encryption key length was increased from 128 to 256 bits. For files contained in RAR and ZIP archives, the maximum path length has been extended to 2,048 characters. File-hashing technology has been improved in the latest version of the software and is called BLAKE2. NTFS hard and symbolic links, as well as a Quick Open record for speeding up the opening of large archives, are also part of the new set of features.

Specific text and multimedia compression techniques aren't supported by the RAR5 file format, which doesn't support individual file comments (but archive comments are kept). It has been decided to delete these options. In RAR5, the file name for partitioned volumes has changed from "archivename.rNN" to "archivename.partNN.rar."There is a trial period of 40 days before the option to purchase becomes available. It's still possible for users to access features that aren't in the enterprise version after the trial period has expired. There are several reasons for this (Borup et al., 2006).

Since 2015, citizens of China have been able to download a free personal edition of the magazine. Copyrighted freeware with a license that allows it to be used in any software is provided by RARLAB for the C++ source code of the current UnRAR unpacker. The RAR format, on the other hand, is a proprietary file format that is not open source. Allowing others to create software that can extract RAR archives but not to create new ones is possible. The Google Play store offers a free version of RAR for Android users. Ads will be shown, but users can opt out by paying a charge. Ad-blocking functionality is not included in a RAR license for Android.

7.2.7 Java Oracle

Originally developed at Sun Microsystems by James Gosling as part of Java, Java is a set of software and specifications. The Oracle Corporation later bought Java, and it now provides a way to create application software and distribute it across different platforms. Gosling penned the code for Java. Java is a programming language that is used in a wide range of computer systems, including embedded devices, mobile phones, and supercomputers. When integrated into HTML websites, Java applets were extensively utilized to provide a variety of native application functions, despite their lower popularity than standalone Java apps (Chadwick et al., 2011). While Java programs were the most popular, this was not the case here. Sandboxes and other risk-free environments were commonly used for their implementation..

The most frequent approach is to build Java code that can be run on a Java virtual machine (VM) (JVM). Other programming languages, such as Ada, JavaScript, Python, and Ruby, have their own byte code compilers. Scala, Groovy, and Clojure are just a few of the languages that can run natively on the JVM. There are some similarities between the syntax of Java and C and C++, although Java's object-oriented features are influenced by Smalltalk and Objective-C. No matter how much escape analysis optimization is used in some implementations, including those currently supported by Oracle, in Java, all variables of object types are references. Developers can avoid low-level structures like pointers thanks to this. Automated garbage collection is used for memory management in the Java virtual machine (JVM). Most of Sun Microsystems' Java software was released under the GNU General Public License (GPL) on November 13, 2006.

In September 2021, Java 17 was made available for download, the most recent version to receive long-term support (LTS). In March 2022, the most recent Java version, version 18, became available for download. Several companies, including Amazon, IBM, Azul Systems, and AdoptOpenJDK, have declared Java their open source platform of choice. Zulu, Amazon Corretto and Liberica are some of the distributions that should be considered. Oracle's long-term support (LTS) editions of both Java 11 and Java 8 are currently supported. Because of the significant security risks posed by Java versions prior to Java 8, Oracle and other sources recommend that previous Java versions than Java 8 be removed promptly(Cao et al., 2006). For this reason, Oracle has urged its customers to "rapidly move" to a supported JDK, including Java 9. Oracle made the final free commercial upgrade to Java 8 LTS accessible to the general public in January 2019. For the foreseeable future, open-source updates for Java 8 will be available for free personal usage. Oracle's continued support for Java 6 ended in December of this year.

7.3 TYPES OF OPEN-SOURCE SOFTWARE

7.3.1 MySQL or MariaDB - Relational Database

It was built by the community to ensure that MySQL would continue to be provided as open-source software that was free to use and was licensed under the GNU General Public License (GPL), which MariaDB was. Since Oracle Corporation's acquisition of MySQL in 2009, a small handful of its original engineers have been leading the project's development. It is common for MariaDB to be used as a drop-in replacement for MySQL because of its compatibility with MySQL's APIs and commands, as well as its library binary parity. Because MariaDB has these qualities, this is possible. New differentiating characteristics are emerging on the other hand. Some of the new storage engines that have been included are Aria, ColumnStore, and MyRocks.

Figure 7.6: MySQL or MariaDB - relational database.

Source: https://images.ctfassets.net/k49d63tr8kcn/6HayCY2MuIWInnbN9eqNHW/96657317a6388334b42b0a62c52d752b/MySQLvsMariaDB.png

Aside from founding Monty Program and MySQL, Michael "Monty" Widenius currently serves as the company's Chief Technology Officer and Principal Developer. When Sun Microsystems and MySQL AB announced their agreement to acquire one another on January 16, 2008, the total acquisition price was roughly $1 billion. When the deal was concluded on February 26, 2008, it was done. Oracle Corporation purchased Sun Microsystems the next year. As for the names MariaDB and MySQL, Widenius' younger and older daughters were the inspirations for their respective names (MacIá, 2005). The version numbers for MySQL and MariaDB were identical until version 5.5. Therefore, MariaDB 5.5 has the same features and capabilities as MySQL 5.5. MySQL, on the other hand, does not have any point releases between version 5.1 and version 5.5, but MariaDB has versions 5.2 and 5.3. The developers of MariaDB concluded that an essential version number upgrade was necessary because of the database's evolution into a variety of different new capabilities.

MariaDB and MySQL have a long history of interoperability thanks to the MySQL protocol (MySQL clients can connect to MariaDB and vice versa), but they have evolved into independent databases with their own set of features and approaches to doing business. MariaDB and MySQL are two of the most popular open-source relational databases available today. When it comes to database management, MariaDB has a reputation for innovation and independence, which is why more and more enterprises are converting from MySQL to MariaDB. The migration from MySQL to MariaDB is straightforward and does not necessitate the modification of any applications or business requirements. This is due to the fact that MariaDB often includes more features, capabilities, and options than MySQL. The MySQL protocol is implemented, and the SQL syntax is compatible with MySQL data types. Besides the standard SQL syntax, MariaDB and MySQL both provide the ability to perform geospatial, window, and common table expressions. In addition to other contributions, MariaDB has added the set operators INTERSECT and EXCEPT, as well as linear regression techniques (Martin, 2010). Partitioning, thread pools, and row compression are just a few of the performance-enhancing features that MariaDB and MySQL implement. MariaDB makes it possible to do read/write splitting, parallel queries, and Redis-based query results caching.

7.3.2 SQL Ledger - Web-Based Enterprise Resource Planning System

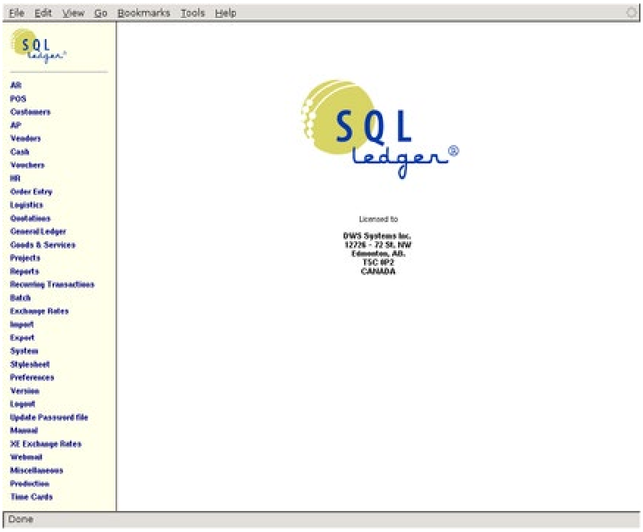

Figure 7.7: SQL Ledger.

Source: https://www.sql-ledger.com/images/mainen-sm.png nSQL-Ledger is a system that deals with ERP and double entry accounting. A standard web browser, such as Google Chrome or Mozilla Firefox, can be used to interact with a SQL Database Server, for example. Using a Perl-created database interface module, PostgreSQL is the database platform of choice for the system's data storage. In addition to Oracle schemas, the downloaded version also contains those for IBM's DB2 database system. Small and medium-sized firms can use SQL-Ledger because it has all of the features that are typically included in accounting software. The framework of a contract for business support services incorporates the ability for specific customizing. It is possible to print statements, invoices, and other papers in the customer's native tongue, even if the user does not understand the language used to print the information (Doi, 2006). When the consumer does not know the language in which the information is printed, this is a helpful feature to have. A standard web browser, such as Google Chrome or Mozilla Firefox, can be used to interact with a SQL Database Server, for example. The entire system is linked together via a chart of accounts. A separate income and cost account, as well as an inventory and tax account, are set up for each item in inventory. Any purchase or sale of a product results in an immediate updating of the accounts.

7.3.3 Android - Mobile Phone Platform

Figure 7.8: Android.

Source: https://techengage.com/wp-content/uploads/2019/04/make-phone-stock-android.jpg

An open-source operating system for touchscreen mobile devices such as smartphones and tablets, Android was created by the Google. Its activities are powered by a modified version of the Linux kernel. The Open Handset Alliance, a group of software developers that Google financially backs, is behind the development of Android. First commercially available Android smartphone was HTC Dream, which was launched in November 2007 and went on sale in September 2008, respectively.

Third-party developers are responsible for the vast majority of Android upgrades. The Apache License serves as the principal governing document for this free and open source software (FOSS) initiative. In many cases, the typically open-source software on a device is rendered unusable after Android is installed on it. The user's access to the source code is either restricted or made difficult by technical means, making the present version proprietary (Liu & Zhang, 2011). Essential programs like Google Chrome, the Google Play store, and the Google Play Services development platform are included with the majority of Android devices' Google Mobile Services (GMS). Most Android smartphones come pre-loaded with GMS. [Note: GMS and Google Play Services are not the same thing.]

Most Android devices use the Google ecosystem, while the rest employ user interfaces and software suites particular to the device's manufacturer (such as TouchWiz and subsequently One UI by Samsung, and HTC Sense).

In addition to Amazon Fire OS and OPPO ColorOS, other Android ecosystems and forks include Vivo OriginOS, Honor MagicUI, OPPO ColorOS, OPPO ColorOS 2, and LineageOS. Google, on the other hand, owns the trademark rights to the term and emblem "Android." By maintaining strict criteria, Google prevents devices that aren't "approved" from utilizing the Android brand outside of the Google ecosystem. It is possible to run Android on a broad number of devices by modifying the original source code, including gaming consoles and digital cameras, as well as portable media players and personal computers. Wear OS for wearables and Android TV for TVs are two significant examples of Google's Android-based products. Aptoide and F-Droid, as well as Google Play Store, Amazon Appstore, Samsung Galaxy Store, Huawei AppGallery, and GetJar, are some of the most common places to find APK files for Android apps, as well as open-source stores like GetJar. Android software packages store their files in the APK file format.

Between 2011 and 2013, Android dominated the global market for mobile devices such as smartphones and tablets. More than three billion monthly active users and more than three million apps were available on Google Play Store in January 2021, making it by far the largest installed base of any operating system as of May 2021. Version 12 of Android was released to the public on October 4th, 2021. In order to run smoothly on battery-powered devices, Android was built from the ground up. The operating system will put a program on hold if it isn't being utilized. In this case, the software will remain open, but the battery and CPU will not be used. To conserve memory, Android will start killing idle processes starting with the ones that have lain dormant for the longest (Lieber, 2003). When it comes to managing memory-resident programs, this is how it is done. Third-party task-killing software should be avoided at all costs, according to an article by Lifehacker in 2011. Alert users to unresponsive background processes with the option to terminate them ("Show all ANRs," or "App's Not Responding"), highlight updating portions of the display, display an overlay with the touch screen's current status, display touching spots for potential use in screencasting and prevent Bluetooth audio from being streamed. In a submenu, you'll find these debugging options. Since the release of Android 4.2 "Jelly Bean," Android's developer settings have been disabled by default. When you're looking at the device information, you'll need to tap the operating system's build number seven times. Remove user data from "Settings" and maybe reset other settings in order to restore the developer's selections.

7.3.4 WordPress - Blog Hosting Platform

WordPress is a free and open-source blogging platform. This implies that anyone, including people who care about the environment, may use it to build and maintain their own websites. A blog, an e-commerce site, a company website, or an online portfolio may all be built using this platform. "Open-source" simply refers to the fact that it is made up of user-generated and shared parts. There is no proprietary software in this process. Web designers with a high level of education cooperate to find and implement new and beneficial solutions that allow others to create WordPress websites that they would not have been able to do. In fact, many of these plug-ins have been designed to help you with all aspects of your website's creation, including the design, navigation, and creation of content itself. WordPress hosting refers to any form of web hosting service that has been specifically designed to work with WordPress-powered websites. If the website is not properly optimized, certain areas of the website may not load, the loading time may increase, or the website may become completely unavailable. This regulation does not apply to WordPress-powered websites. As a consequence, your website's visitors and customers may decide to leave, which might lead to a big drop in traffic and revenue for your company (Liu & Ihl Woo, 2006).

If you're on a limited budget, you may host your WordPress website on shared hosting. Using a server that doesn't meet the needs of the WordPress platform is a common problem for users of the platform. In a hosting system known as shared hosting, resources like disk space and bandwidth are shared across all of the accounts on the server. Due to increasing competition for resources, your website's speed and load time may suffer. Small companies may afford shared hosting, which provides some degree of customer support; but, this type of WordPress hosting is often insufficient for the needs of larger or more complex firms. When hosted in a shared hosting environment, WordPress-powered websites typically share server space with websites built on other platforms. As a result, server administrators must be able to manage websites built on platforms other than WordPress. As a result, the quality of the technical support supplied may be significantly reduced.

As a result, a large number of websites are frequently hosted on a single shared server In order to make a profit, hosts must jam a large number of users onto each virtual server space because of the low cost of delivering the service. From a financial standpoint, this makes great sense. There may be a decrease in the quality of work performed by a support staff person due to overwork, which is the result of having to give assistance to a high number of customers. In order to meet all of their hosting needs, individuals who want faster speeds or additional security measures will have to go elsewhere.

7.3.5 Drupal - Enterprise Content Management System

Drupal is a web content management system. Almost all of the websites and mobile apps you use on a daily basis were built on top of this technology foundation. In addition to its excellent security, constant performance and simple content editing, Drupal has a number of other exceptional features. To be sure, its adaptability is what makes it unique and serves as a guiding principle. To create dynamic online experiences, you need content that is adaptable and structured. This is possible because of its properties.

Among the many countries in which Drupal is used to communicate with the locals is the United States, as well as London and France (Kobayashi et al., 2019). In this way, media outlets like the BBC, NBC, and MTV UK, among others, can produce informative and entertaining content. It is in this spirit that Amnesty International and Oxford University are teaming up on this endeavor.

Until the beginning of 2011, Drupal 7 has been available to the general public.

Programmers can build and integrate reliable solutions for demanding businesses with the Drupal Enterprise Content Management System (DE-CMS) distribution. A lightweight Drupal 8 enterprise framework, extensive documentation, and applications that excel in their respective categories serve as the foundation for the development of functional solutions. The core functionality of a CMS can be found in Drupal's standard distribution, which is also known as Drupal core. User accounts, RSS feeds, and taxonomies are all part of system administration. Changing page layouts is also part of system administration. Simple websites, blogs with one or more users, forums, and communities that accept user-generated content can all be created using the Drupal core installation as the basis for their development. Using Drupal, you can accomplish all of these. It is also marketed as a framework for developing Web applications. Only Drupal meets the vast majority of the basic competency criteria for web frameworks, when compared to other well-known frameworks (Howe-Walsh & Turnbull, 2016). If you have a basic knowledge of HTML and CSS, all which is needed to build a simple website or administer the Drupal framework is an API for developers. Almost any computer system with a PHP web server and a database capable of storing content and customizations can run Drupal.

"Core" refers to the codebase developed by the Drupal community and kept outside of the "sites" folder of a Drupal installation prior to the release of Drupal 8. The codebase is referred to as "Core" because it has been supplemented by donated modules. Core files are stored in the "core" directory only (as of version 8). This is the most critical part of Drupal. Any new Drupal functionality, including the system module, can be defined in a Drupal module. The core of Drupal is made up of libraries that are specific to Drupal, as well as a mechanism for getting started(Dhillon et al., 2017).

Content creators working with Drupal-powered websites have the option to publish their work as either registered or anonymous users by default (at the discretion of the administrator). To find this data, you can perform a search on the internet with a variety of different criteria. Many Symfony libraries are now part of the Drupal 8 core distribution.

Developers can classify and keyword-tag content using a hierarchical taxonomy system that is built into the core modules. Core modules are used to achieve this goal. Each Drupal release includes a detailed changelog listing all of the changes made to the core functionality.

7.4 COMPARISON OF SOFTWARE AND OPEN SOURCE

To determine whether a company should build software using open-source or proprietary methods, the decision must be made by each company. In contrast to the commercial software industry, the open-source software community is full of developers and programmers who have no qualms about commercializing their work. Because both models have both positive and negative aspects, it's easy to see how they differ. When it comes to choosing between open-source and proprietary software, it can be difficult. The only thing you can be sure of when faced with a difficult decision is that "it depends." In terms of distinguishing features and traits, one option has a slight advantage over the other. One can't say that they are utterly in conflict with one another with complete accuracy (Hagendijk & Irwin, 2006). Allowing coders and programmers the ability to access and update source code whenever necessary is a control-seeking idea. An additional benefit for non-programmers is the positive correlation between increased control and increased flexibility.

Proprietary software, on the other hand, can only be controlled by the person who owns it. It is possible for anyone with the necessary skills to modify the program's source code in order to make it perform better in any way they choose. As a result, software bugs can be continually fixed. This allows developers to fix issues that may have gone unnoticed by the game's creators or publishers. Drivers are frequently omitted from open-source software because customers have complete access to the source code. Many people could have made modifications to the software, and each one may have done so in accordance with their own set of standards. If the project does not have a formal sponsor or if generic drivers are used, it could suffer. Closed group support enhances the performance of proprietary software. As with private projects, rather than open-source ones, it is common practice to design with a smaller, more experienced user base in mind when designing for private projects (Granato et al., 2014). This sets them apart from open source community initiatives in that they are designed for a specific group of end users. Aside from viewing the code, non-programmers are unable to alter anything.

CHAPTER 8

THE 5 MAJOR FIELDS OF ROBOTICS

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INTRODUCTION

Robotics is the science and technology of making machines that can perform tasks more efficiently than humans. In short, it is the development of technologies to build robots to help with things like cleaning the house, working on cars, or even performing surgery. The first person to create a robot was a Dutchman named Eduard Zijlstra in 1895. He created a mechanical arm with three joints that could lift objects to 70 pounds over his head. This invention led to many other developments in robotics as we know them today.

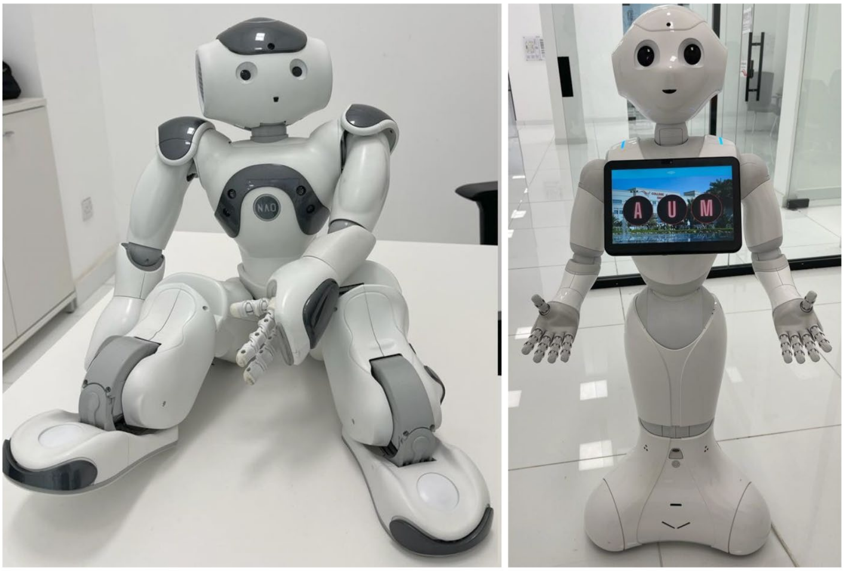

Figure 8.1: Softbank Robotics Nao (left) and Pepper (right) robots at the American University of the Middle East.

Source: Youssef K, Said S, Alkork S, Beyrouthy T. A Survey on Recent Advances in Social Robotics. Robotics. 2022; 11(4):75. https://doi.org/10.3390/robotics11040075

Robots can be used in the industrial, manufacturing, and service sectors to perform tasks that are too dangerous or repetitive for humans to do. Robots can sense their environment and make decisions based on this information, such as avoiding obstacles or following commands from humans (Grupp & Mogee, 2004). This technology has been around for decades but has only recently become affordable to smaller businesses that may not have the necessary capital investment or expertise needed to build these devices themselves.

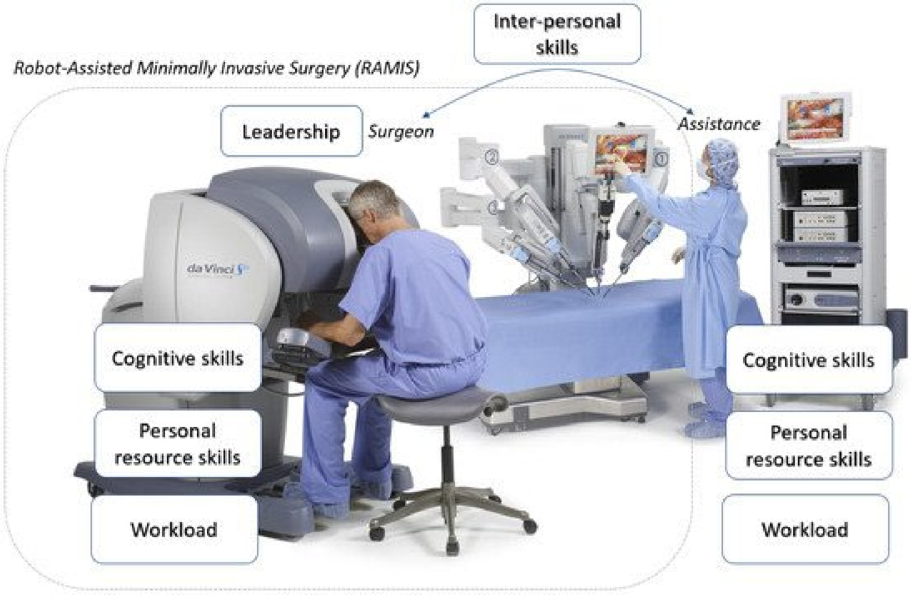

Figure 8.2: An image showing robotic surgery.

Source: Nagyné Elek R, Haidegger T. Non-Technical Skill Assessment and Mental Load Evaluation in Robot-Assisted Minimally Invasive Surgery. Sensors. 2021; 21(8):2666. https://doi.org/10.3390/s21082666

Robotic surgery is a type of medical specialty that involves the use of robots to perform surgeries. It combines surgical instruments with feedback control systems and artificial intelligence, allowing surgeons to operate without any risk of injury or error. Inventors have been developing robotic devices since the 1970s, but it was only after 1990 that major advances were made in this area.

Robotics has become an integral part of modern medicine, allowing doctors to perform complex procedures such as kidney transplants and breast biopsies without putting patients at risk for infection or other complications associated with human touch during surgery

Robots are used in many industries, including automotive, food and medicine, construction, and logistics. Robots can be used for many tasks humans cannot perform alone. They may assist with manufacturing processes such as welding or painting; they may also help in the production of goods such as packaging or assembling parts into larger units. For example, A robot arm controls an X-ray machine that scans patients' bones during surgery to determine whether any abnormalities need further treatment before proceeding with the surgery itself; this type of robot has been called a "surgeon" because it can perform complex tasks more efficiently than humans could do them manually (and also because this particular kind of robot has been designed specifically for use inside hospitals (Gandini, 2011).

Robotics is also one of the most prominent fields in artificial intelligence (AI). In simple terms, robotics is the use of computers or other technology to control machines or devices that do not traditionally have human operators. The field includes mechanical engineering, electrical engineering, and computer science; it also includes software development for robots. Robotics is also referred to as automata, a term first used in 1545 by Giovanni Battista Della Porta.

8.1 GENERAL FIELDS OF ROBOTICS

Robotics is a broad term that covers several different fields. The major ones are listed below, along with some additional categories that are sometimes considered part of robotics but not necessarily considered fields or disciplines in themselves.

8.1.1 Military Robotics

Military robotics is a subfield of robotics that focuses on military applications, such as the design and construction of unmanned systems for military purposes. The technology can also be used to monitor enemy activities from afar, or in support of other soldiers' operations. Military robots are often remote-controlled by humans who direct their movements via a radio signal or video feed (Ferrari et al., 2015). They're often equipped with cameras and sensors allowing them to detect objects in their surroundings and respond accordingly—for instance, if a robot detects an enemy soldier nearby, it will raise its weapon and aim at him or her.

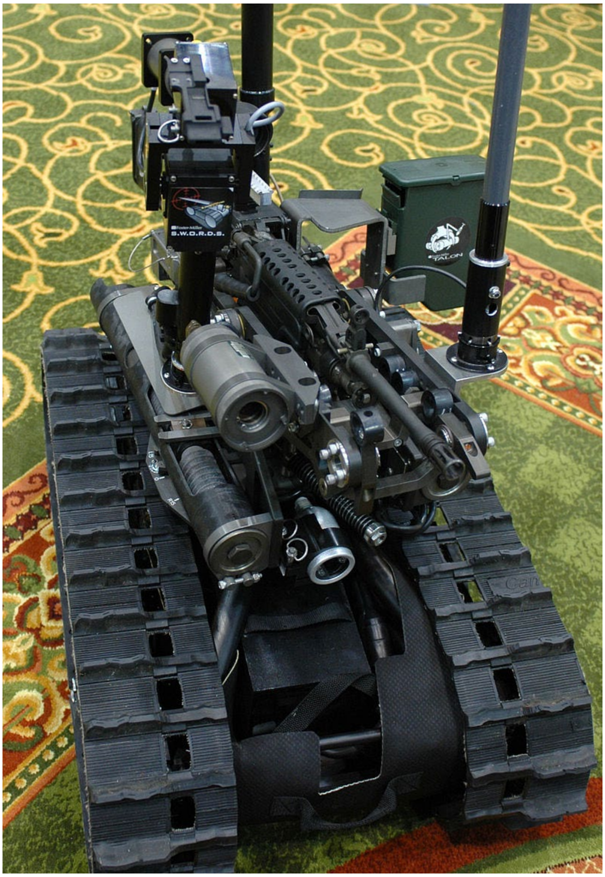

Figure 8.3: An image showing military robotics.

Source: Public Domain, https://commons.wikimedia.org/w/index.php?curid=65869

8.1.2 Space Robotics

Space robotics is the field that studies robotics and its applications in space. Space robotics is also known as space exploration because it involves the use of robots for exploring planets or satellites in outer space. Space robots are used for many purposes including mining minerals from asteroids, transporting cargo in interplanetary missions, and performing maintenance tasks such as cleaning up debris left by meteors or planetary bodies' collisions with Earth's atmosphere.

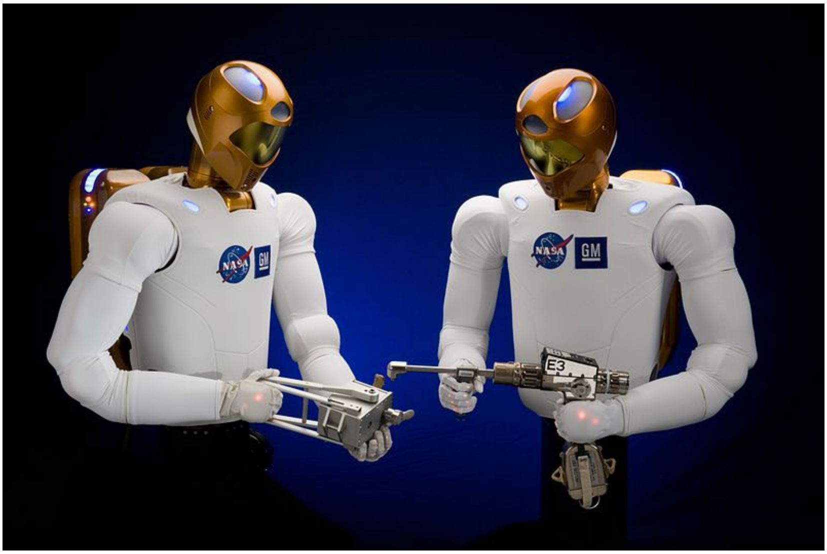

Figure 8.4: An image showing a robot in space.

Source: By NASA - [1] on Robonaut 2 Gallery, Public Domain, https://commons.wikimedia.org/w/index.php?curid=14530326

8.1.3 Medical Robotics

Medical robotics is a growing field, and it can help people who are suffering from a disease or have lost the ability to move. The medical robotic system will be able to operate independently, allowing the patient's condition to be monitored and treated remotely(Ferguson & Zhang, 2002).

In this case, medical robotics takes on several roles: Emergency response – if someone falls into water or gets injured in any way (e.g., burns), they may need emergency assistance immediately; however, there isn't always time for their loved ones to call 911 before they arrive on the scene with an ambulance or fire truck. With robotic assistance available 24/7 via an app on your phone/tablet computer screen—even while you're sleeping—you'll never miss another opportunity again. You'll never have another chance at saving someone's life because you slept through it.

8.1.4 Material Handling

Material handling robots are used to automate the movement of materials. They can be used to move products, tools, and equipment in factories. For example, A robot arm performs repeated repetitive movements that are tedious or dangerous for humans to do, for example, lifting heavy objects. A material handler uses an overhead crane system to lift a pallet with several boxes on it into its conveyor belt system where they will be loaded onto trucks for delivery elsewhere in the factory.

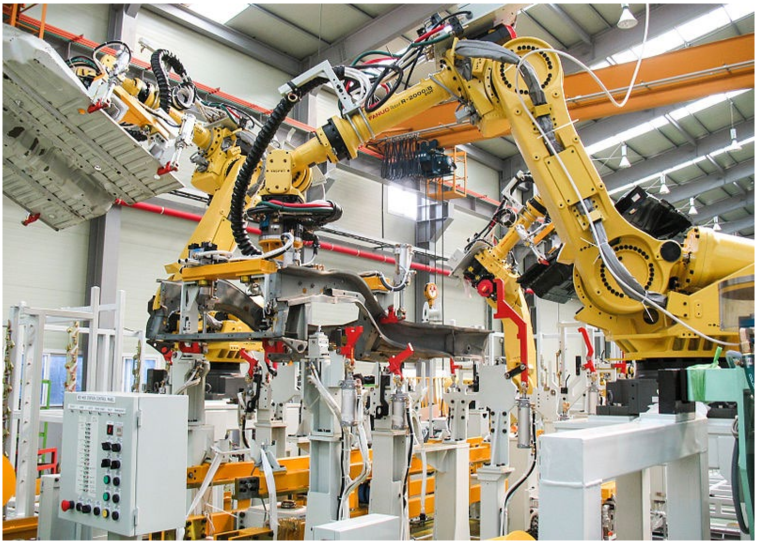

Figure 8.5: An image showing a robot in material handling.

Source: By No machine-readable author provided. Mixabest assumed (based on copyright claims). - No machine-readable source provided. Own work assumed (based on copyright claims)., Public Domain, https://commons.wikimedia.org/w/index.php?curid=9558733

8.1.5 Education and Research

Robotics is a field that requires research and development, education, training, teaching, and/or school systems. The fields of robotics are too wide to be covered in one article. In this section, we will focus on some of the main ones: Research, Education, Training (usually done by universities), and Teaching (usually done by schools) (Floros et al., 2010).

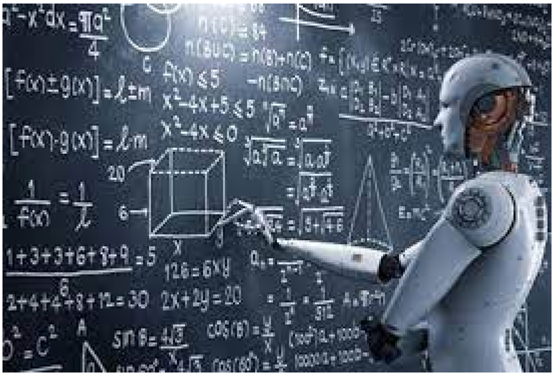

Figure 8.6: An image showing a robot being used in education.

Source:https://www.frontiersin.org/research-topics/9924/robot-assisted-learning-and-education

8.1.6 Hazardous Environment Robotics

Hazardous environment robots are used in mining, construction, and other industrial settings. They can perform tasks that are dangerous for humans to complete, such as digging through the ground or drilling into rock. This type of robot is also called an autonomous mobile manipulator (AMM).

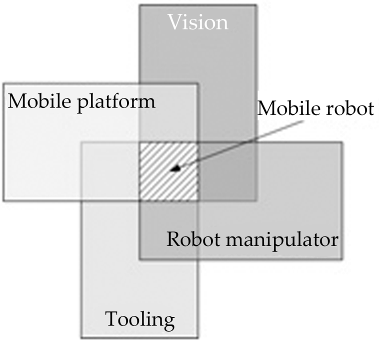

Figure 8.7: An image showing a robot being used in a hazardous environment.

Source: By Hvilshoj - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=9016300

8.1.7 Underwater / Marine Robotics

Underwater robotics is a fast-growing field of robotics. Underwater robots are used for ocean exploration, ocean monitoring, ocean conservation, and ocean exploration. They are also used to study the ocean floor, ocean currents, and the environment of the deep sea.

One example of an underwater robot is Jason 2 which was launched on July 7th, 2016 from Cape Canaveral Air Force Station in Florida to investigate undersea volcanoes near Hawaii's Big Island. It will study how these volcanoes form and what they're made up of so scientists can make better predictions about future eruptions at those sites (Foest et al., 2006). This type of research could help people living near them evacuate before an eruption happens or avoid being harmed by flying debris during one if they do happen to occur someday soon.

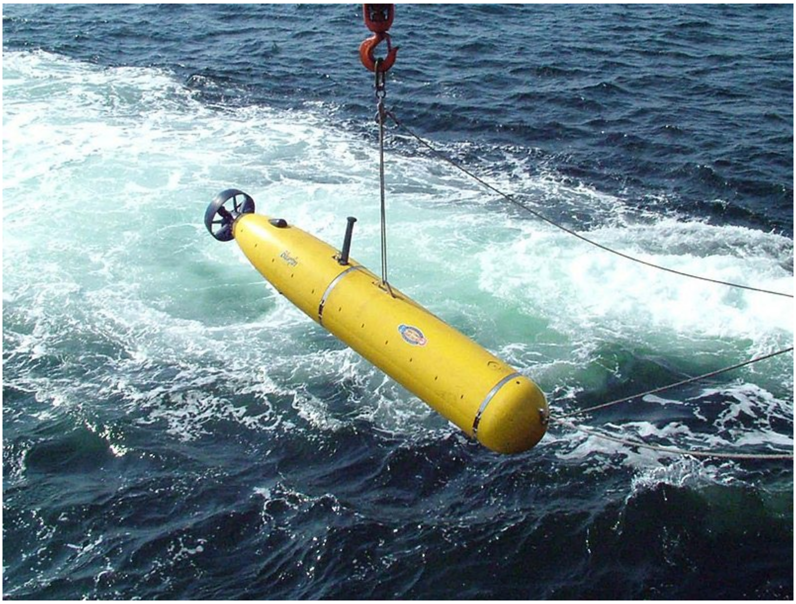

Figure 8.8: An image showing a marine robotic system.

Source: By Bluefin, Attribution, https://commons.wikimedia.org/w/index.php?curid=12099906

The major robotics fields are pretty different from each other. For instance, Industrial robotics focuses on the application of robots in industrial settings and manufacturing processes. Robots are used to perform tasks that would be difficult or impossible for humans to do, such as welding, painting, and packaging. Reinforcement learning (RL) is a branch of machine learning that uses rewards and punishments to teach machines how best to do their work using trial-and-error methods. It's designed for situations where humans aren't available because it doesn't require any prior knowledge about what objects look like or how they move around; instead, all you need is a few examples of how things were done before so you can see if your current plan will work out successfully instead of just guessing blindly like most other AI systems out there today.

8.2 MAJOR FIELD CLASSIFICATION OF ROBOTICS

The invention of robotics is based on five major fields which ought to be followed sequentially; ensuring that the final product is of high quality and functioning properly. The five fields include; the Manipulators and Effectors field; the programming field; the operation and interface field; the mobility or locomotion field; and the security and perfection field(Foest et al., 2006).

8.2.1 Manipulators and Effectors in Robotics

A robot manipulator is a mechanical arm with joints that allow it to reach out and grasp objects with precision. An effector is attached to the end of this arm and can be programmed with functions such as opening a door or manipulating an object. This pair of terms was coined in the 1960s by Rodney Brooks and his colleagues at MIT's Artificial Intelligence Laboratory (AIL). A manipulator is the part of a robot that interacts with its environment, often to perform a specific task. Manipulators can be rigid or flexible and have one or more joints. They may be able to move in any direction (for example, up and down) or only in one direction (for example, forward).

Manipulators generally consist of one end effector, which is typically an appendage used for grasping objects; and two main axes: X-axis (horizontal) and Y-axis (vertical). The X-axis usually runs along the centerline while the Y-axis runs perpendicularly to it along its length.

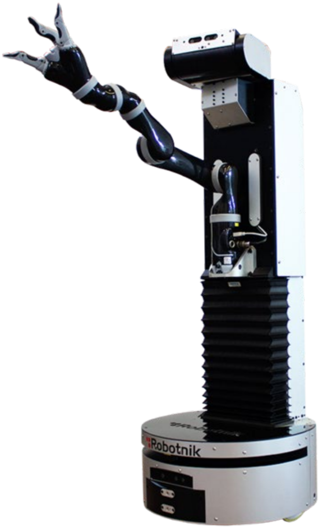

Figure 8.9: An image showing a robotic manipulator.

Source: By Mgomezrobotnik - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=57272369

An effector is a tool used to complete a task. It can be of different types, sizes, and shapes. For example, a hammer is an effector used to drive nails into wood or metal; whereas a screwdriver is an effector used to tighten nuts and bolts onto their respective objects. Effectors also vary in material properties such as weight (compared with their size), and effort required for movement (for example, pushing versus pulling), among others.

Manipulators are tools that robots use to interact with the environment. They can be used for manipulation (for example, picking up objects) or effecting (for example, moving an object). Effectors are components of robotic systems that perform physical changes in the world, such as pushing or pulling objects, and opening doors, among others (Foest et al., 2006).

Manipulators and effector systems are blocks that can be used in different ways to perform different tasks. Manipulators allow us to manipulate objects, while effectors allow us to perform actions on objects. Manipulators are often found on humanoid robots, like NASA's Robonaut 2 (R2), which uses a pair of arms for tasks such as lifting heavy objects or grabbing materials from far away. Effectors can be found on any robot, whether it's pulling pins from fabric or moving boxes around storage rooms -- they're just another set of tools we use every day!

8.2.2 Manipulator Joints

In robotics, a manipulator is an arm or other mechanical device that can be moved around to perform a task. A manipulator can be used in a variety of ways—for example, it could be used to pick up or move objects, or to hold them in place. Manipulators are often used in conjunction with another type of machine: an effector. An effector is a sensor that detects something about the environment and then sends information about that object back to the control system. The control system uses this information to determine how to actuate the manipulator and its effectors, making sure that they are moving in the right way at the right time (Foest et al., 2006). The manipulator is typically made up of three components: the base, gripper, and arm. The base is usually composed of two parts: a fixed platform that provides stability and a set of joints that allow it to move freely. The gripper part may include one or more hands connected to the arm by flexible links. It is often made out of plastic or metal and has one or more fingers that grasp an object to move it.

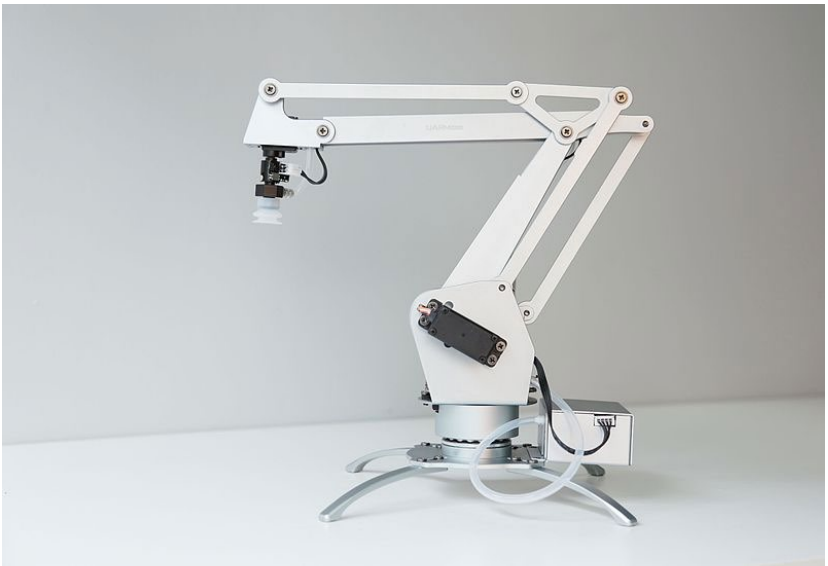

Figure 8.10: An image showing the manipulator's joints- uArm Metal Commercial Robot Arm.

Source: By Siaopan - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=50386842

Joints allow an effector to move in a specific direction or orientation, as well as bend from side to side. Manipulators that have jointed arms can pick up objects, rotate them, and move them around the workspace. They can also be used for positioning and holding objects. One example of a jointed arm is the Robotic Hand -a tool that allows you to operate the robot without touching it directly. The robot uses this tool to help you operate it while you use your hands to manipulate other objects. The shoulder is another example of a jointed arm--it allows you to tilt the arm up or down while still holding onto something with your hand (Zhang et al., 2018).

The most common type is the universal joint, which allows for movement in any direction along three axes: forward, backward, and side-to-side (or diagonal). Another type is the double-joint, which allows for more flexibility in how it can be positioned. In some cases, dual-jointed manipulators may even include three axes of freedom (also known as 3DoF). Manipulators typically include two types of joints: linear joints and rotary joints. A joint is part of a mechanism that allows one part of an object to move relative to another part of the same object. Linear joints allow only straight-line motion; rotary joints allow both straight-line and circular motions.

8.3 CLASSIFICATION OF MANIPULATORS

This is a classification of end-effectors based on their ability to manipulate objects. The manipulator is the part of the robot that manipulates objects. This part may be a hand, a tool, or another part of the robot. An end-effector is an extension of the robot that can be used for manipulating objects.

A planar manipulator is a type of manipulator that uses a single linear actuator to move the end effector. The end effector is the tool that a robot uses to perform its tasks and can be as simple as a screwdriver or as complex as an actual tool. Planar manipulators are also known as linear robots because they have one moving part: their actuators (the motors). Planar manipulators are robots that can sense their environment, move and manipulate objects in space, and perform tasks. They are typically three-dimensional, with a pair of arms that can move in any direction (Zeldin et al., 2008). Their ability to sense and manipulate objects depends on the type of sensors used. Some examples of planar manipulators include the gripper on the hand of a human or animal, and, a robotic arm with end effectors (tentacles).

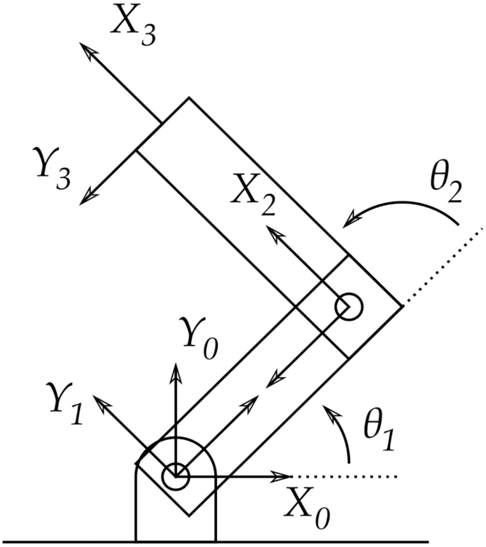

Figure 8.11: An image showing a planar manipulator.

Source: https://commons.wikimedia.org/wiki/File:Planar-manipulator.svg

Small manipulators are handheld tools that are used in manufacturing or construction. They are typically used to hold objects and move them around. These manipulators have a small range of motion and tend to be quite cheap. Medium-sized manipulators are often used in industrial settings as well but may also be found in other areas such as healthcare or transportation. These manipulators have a medium range of motion and cost more than small manipulators but less than large ones. Large manipulators can be found in many different applications including industrial settings where they are used for maintenance purposes (such as welding) or heavy-duty work such as lifting heavy loads over long distances (such as moving cargo containers). These manipulators typically cost more than medium-sized ones but less than small ones.

Spherical manipulators as used in robotics can be described as a type of manipulator that can rotate an object around its center point. Unlike a linear manipulator such as a track, the spherical manipulator moves an object through a full 360 degrees. Spherical manipulators use various external forces to create motion, most commonly gravity (falling), electromagnetic motors, pneumatic actuators, and hydraulics. They are often used in industrial automation systems and robots used for packaging, transportation, and other industrial applications (Antal & Grønli, 2003). Spherical manipulators were first developed by NASA in the 1970s when researchers were looking for ways to make robots more efficient and effective. These manipulators are now widely used in robotics research projects around the world.

Spatial manipulators are a type of manipulator that use a combination of motors, gears, and pneumatic actuators to control the movement of objects. Spatial manipulators are used in robotics as a class of manipulators. One example of a spatial manipulator is a robot arm. A robotic arm has two joints that allow it to move in either direction (forward or backward). It also has an elbow joint and a wrist joint that allows it to bend and twist at certain angles. This allows the robot arm to reach out and grab objects from different directions. Spatial manipulation systems are common in industrial robotics because they allow robots to move around their workspace without needing to be tethered to it by cables or other types of tethers. This allows for greater autonomy in some applications where safety is needed but mobility is not required (such as when working around hazardous materials). Spatial manipulation systems also allow for more flexibility than other types of manipulators because they do not require an external power source (other than what comes from the actuators themselves). The most common type of spatial manipulator is the joystick, which requires a person to move the joystick around to control how far it moves. This is a very common type of spatial manipulator because it allows for manual control over motion and position. Other types include pneumatic cylinders, hydraulic cylinders, and electric motors that work similarly to these but require less physical labor from the user by not requiring them to directly touch any parts of their bodies while operating them (such as pressing buttons).

Open-loop manipulators are used in robotics as a type of manipulator. They have a direct action on the object being acted on and do not require any feedback from that object to control their motion. This means they can be used without any additional sensors, or without any feedback or control systems in place to detect errors or anomalies in their actions (Wu et al., 2019). Open-loop manipulators have been used for many years in robotics, but recently there has been a new kind of manipulator called a closed-loop manipulator. Closed-lobe manipulators are less expensive than open loop manipulators and can be controlled more easily by the user.

A hybrid manipulator is a type of robot manipulator that combines the motion of two or more types of actuators. Hybrid manipulators are used in robotics as an alternative to using a single type of actuator. They can be used in applications such as reaching and grasping, where the movement of one joint could be too slow or too high-speed for a single type of actuator to handle effectively. Hybrid manipulators typically consist of three parts: a motor, a gearbox, and a power supply for the motor. The motor generates electrical power through either direct current or alternating current (AC). A gearbox transfers this power from the power supply to an electric actuator (such as a servomotor or pneumatic piston) that moves the joint.

8.4 PROGRAMMING IN ROBOTICS

Programming is a major field of robotics. Programming is the process of planning, designing, and implementing instructions for a robot to follow. Robots are built to do specific tasks in certain environments, and their abilities are limited by their programming. Programmers create programs that tell the robot what to do for it to complete its task.

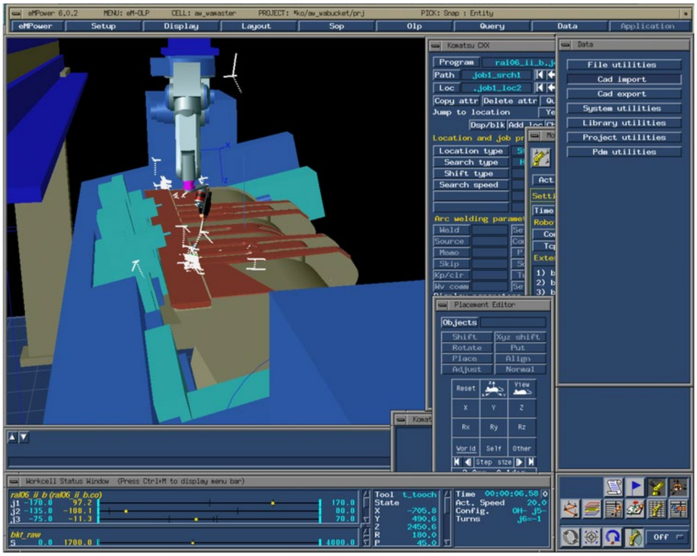

Figure 8.12: An image showing robotic offline programming.

Source: By KOMATSU Ltd - KOMATSU Ltd, CC BY-SA 2.1 jp, https://commons.wikimedia.org/w/index.php?curid=259520

The first step in programming is deciding on the task that you want your robot to perform. For example, if you want your robot to pick up some boxes from a pile and place them on a shelf, you would create a program that tells it how many boxes there are in each pile, how many piles there are in total, and how many shelves there are in your warehouse. You would also need to know the location of each box and shelf so that your robot knows where to go when it's picking up boxes or placing them on shelves.

Once you have decided what kind of task you want your robot to perform, you can start designing it with programming languages like C++ or Java. These languages allow programmers to write programs that tell robots what actions they should take under certain circumstances (Woolgar & Lezaun, 2013). The most common programming languages used today include C++ and Java because they are easy enough for beginners but powerful enough for professionals who work with complex problems every day.

The field of robotics has seen a steady increase in its popularity over the last few decades, as evidenced by its growing presence at trade shows and conferences. The robots themselves can be used in different industries, but there are also many other ways that you can use robotics technology to your advantage. In this article, we will discuss some of the most important aspects of programming as well as how it relates to robotics. We'll also talk about some popular examples of robotic applications and how they relate to each other

Robots are used in factories, homes, and hospitals. They can do tasks that are dangerous or repetitive. Robots can also be used to do things that are too difficult for humans. The industrial revolution brought about the first robots which were designed to do simple tasks such as moving materials around on factory floors or lifting heavy objects off assembly lines. Today's robots are much more sophisticated than those from 50 years ago; they may even be able to learn how to operate independently over time (Wang, 2009).

Robotics is a field that has been around since the mid-20th century. It has become an integral part of our lives, and it will continue to do so as time goes on. The mechanical robot is the foundational element of all human activity; without them, we would not be able to do many things that we take for granted today.

Robots can be used in many different ways: they can assist with military operations by providing support for soldiers on the battlefield; they can help astronauts explore space; they can work in manufacturing lines helping workers produce more efficiently; robots are used in medical facilities where they assist doctors during surgeries or other procedures (such as taking x-rays); robots can even be programmed so that they could teach children how math works so that kids understand how these concepts apply throughout their lives!

A robot is a machine - particularly one programmable by a computer - capable of carrying out a complex set of actions automatically. A robot is not an artificial intelligence (AI) system, which has been defined as “a system that can learn and adapt to new situations”. Instead, robots are composed of mechanical systems interacting with each other through feedback loops to carry out tasks that require precision and repetition over long periods.

If a robot has an external control device, it can be moved around by an operator who uses the controls to move the robot in a certain direction. In this case, the operator must be able to see what he or she is doing since there are no cameras present. On the other hand, if a robot has internal control systems embedded within its body, then it does not need external devices for movement because these systems take care of everything for them (Wynne, 2007). This type of system is often used in industrial robots because they need to perform tasks quickly and efficiently without much human intervention required (i.e., no moving around).

In 1947, Norbert Wiener formulated the principles of cybernetics. Cybernetics is a branch of science that studies control and communication in biological systems such as animals, plants, and humans. Wiener’s work was based on the theory of feedback. Feedback means that when something changes in a system, it causes another thing to change as well; this is an example of negative feedback because it occurs when something decreases or goes back to its original state (e.g., if your heart rate decreases after you run upstairs without taking breaks).

Wiener’s work was a major contribution to robotics because he developed mathematical models of how humans interact with their environments through systems such as thermostats or traffic lights which use positive feedback instead. AI is a branch of computer science that studies how computers can perform tasks that would be difficult or impossible for humans to do, such as visual perception and speech recognition.

Robotics is a field that has many applications in today’s society. Robots are used in manufacturing, healthcare, agriculture, and the military. They’re also used in home automation as well as entertainment and research. It’s important to remember that these robots have been designed with human-like intelligence because they need to be able to interact with their environment for them to carry out their tasks efficiently and effectively.

We’ve come a long way from the days when a robot was only as smart as its creator. Today’s robots are much more sophisticated and capable than they were in the past, thanks to advances in computer technology and artificial intelligence. The result is that more and more we see robots taking on human tasks. These days you can get your hands on an affordable robotic arm for home use or even customize your assistant robot—and it won't cost you thousands of dollars (Woellert et al., 2011). These advancements mean that robotics will continue its rise from a niche industry into mainstream society as people begin realizing how beneficial these devices can be for their everyday lives.

8.4.1 Operator Interface in Robotics

Operator Interface (OI) is a major field of robotics. It involves the human-machine interface, which includes the software and hardware that allow humans to control robots. Robots are becoming increasingly autonomous and intelligent. They can perform tasks that were once reserved for humans, such as driving cars or playing video games. This means that people need to be able to operate these machines without being aware of how they are doing so.

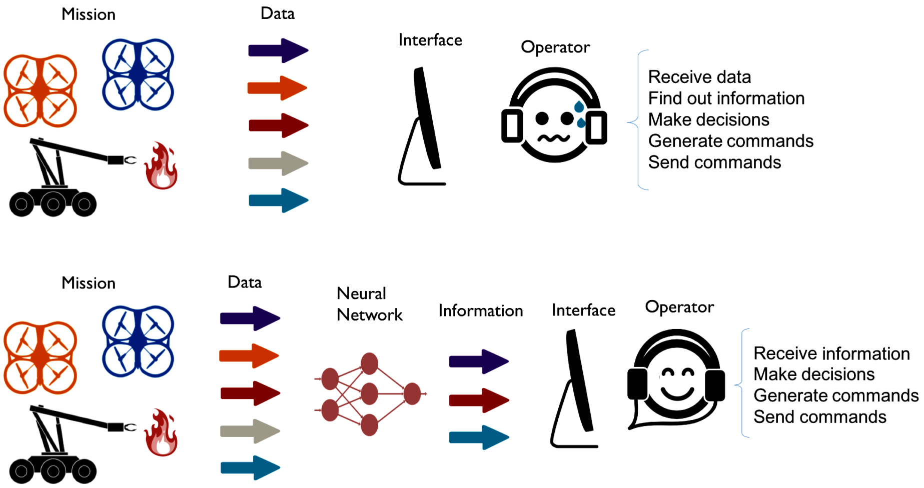

Figure 8.13: An interface.

Source: Roldán JJ, Peña-Tapia E, Martín-Barrio A, Olivares-Méndez MA, Del Cerro J, Barrientos A. Multi-Robot Interfaces and Operator Situational Awareness: Study of the Impact of Immersion and Prediction. Sensors. 2017; 17(8):1720. https://doi.org/10.3390/s17081720

The operator interface can be implemented through various means, including voice recognition software and touch screens. However, it is important to note that while these methods may seem simple and easy to use, they are not always ideal for robots. For example, touch screen interfaces require the user to make physical contact with their device to interact with it. This can be difficult for elderly users or anyone who has poor eyesight or limited mobility. In addition, voice recognition software requires that the user talks into a microphone which can be somewhat awkward or uncomfortable for some people. In response to these shortcomings in traditional input methods for robots, many manufacturers have developed motion-based interfaces that allow users to control their robots without physically touching them (Whitcombe et al., 2014). These motion-based interfaces allow users to move around freely within a virtual environment while still interacting with their robotic companion on an equal level.

Operator Interface takes two forms: physical and virtual. The latter involves using a computer screen or tablet to interact with a robot; this is what most people think of when they hear "operator interface." However, physical operator interfaces involve humans physically interacting with robots through their bodies while they control them via buttons, joysticks, etcetera—this is how most commercial robotic systems work today. Physical Operator Interface: Manual, and Mechanical or electrical (robots controlled by switches/switches).

The field of robotics has many branches, with a focus on automation, intelligence, and physical capabilities. One of the major aspects of this is the operator interface (OI). The OI is about systems that enable robot operators to understand the task being performed by their robots. This involves an understanding of the human-robot interface and its role in task performance. Operator interfaces should be grounded in knowledge of task requirements and human capability. It turns out that effective operator interfaces are critical components of many robotic systems

The operator interface should be designed so that it is easy for an operator to use the system in their work environment or home environment as well as when performing tasks around the house or yard. If there are several different systems available then each one should have its operator interfaces so that they don't interfere with each other's operation (e.g., if you want your smartwatch but also want your phone).

The human operator is a joint component of the system as a whole. To be sure, the operator doesn't need to be considered part of any single subsystem; rather, he/she can be regarded as an integral part of any robotic system regardless of its characteristics and goals. In this sense, he/she represents a distinctive kind of entity within robotics that differs from other entities such as hardware or software components (Adamovich et al., 2017). This involves an understanding of how humans interact with robots to achieve their goals through manipulating objects using physical gestures such as pointing or gesturing with arms; speaking commands over speech recognition systems.

The design of operator interfaces should be grounded in knowledge of task requirements and human capability. When designing a robot, it is important to consider both the cognitive abilities of the individual user and their physical capabilities. The complexity of an interface will depend on its function: if you're performing simple actions like turning off a light switch or opening a door then your interaction with your system will not require much thought on behalf of yourself or others around you. However, if you need to perform complex tasks such as driving a vehicle or operating machinery then these interactions may require more mental effort from users since they involve multiple steps (for example, pushing buttons) which could lead to errors if performed incorrectly.

It turns out that effective operator interfaces are critical components of many robotic systems. The design of an operator interface is a very important but often neglected aspect of any robot system. It can make or break your task performance! For example, if you're operating a factory production line, the quality and speed at which you perform each task will determine how much product gets produced per hour—and how much profit your company makes from each unit sold.

An interface to be effective means that it must satisfy certain criteria such as being easy to use without sacrificing accuracy and precision; being efficient with limited resources (such as time); producing optimal results on average across all users; providing feedback mechanisms that work well in practice while preventing errors from occurring during normal use (Verbeek et al., 2002).

The design of operator interfaces can make or break your task performance. The human operator is a joint component of the system as a whole, and it's critical for many robotic systems to be able to communicate with their users to achieve their goals.

8.4.2 Mobility or Locomotion as a Field in Robotics

Mobile robots are robots that can move. They may be wheeled, legged, or winged like MAVs and drones. A robot is a machine that can move. Robots can be mobile or stationary, man-made or biological. They may also be software-only or hardware-only. There are many types of robots used today in robotics research and development: Mobile Robots: These are designed to follow human instructions and perform tasks like surgery on the battlefield or search for survivors in natural disasters like hurricanes (iRobot). Stationary Robots: Examples include industrial robots used for welding equipment at factories (FANUC), cleaning floors with vacuum cleaners (LG), and moving boxes around warehouses (iRobot). The wheeled robot is the first and simplest method of mobility (Terrones, 2003).

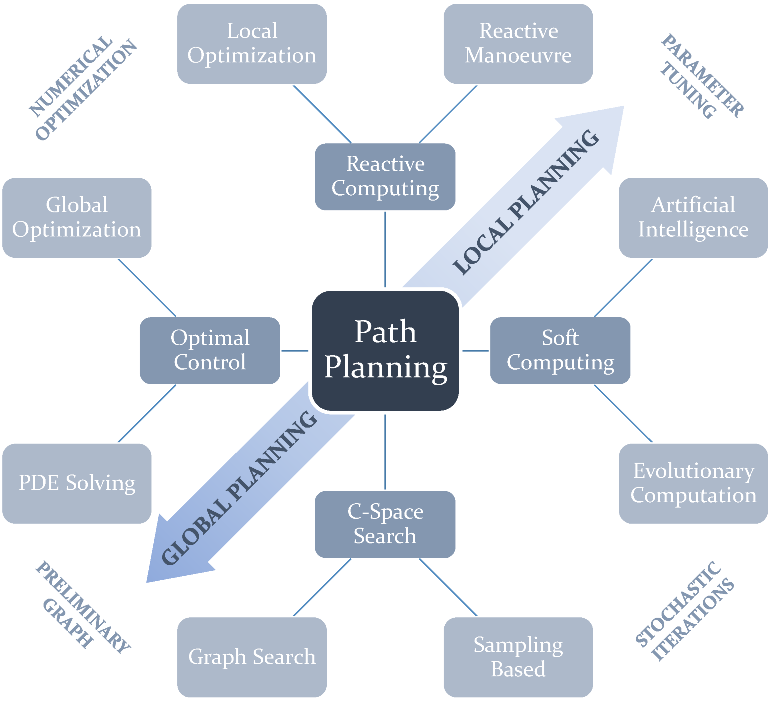

Figure 8.14: Planning the path.

Source: Sánchez-Ibáñez JR, Pérez-del-Pulgar CJ, García-Cerezo A. Path Planning for Autonomous Mobile Robots: A Review. Sensors. 2021; 21(23):7898. https://doi.org/10.3390/s21237898

The wheeled robot is the first and simplest method of mobility. It is most popular due to its ease of use and efficiency, as well as its reliability. This means that you can build a robot that can move easily around your house or office without having to worry about whether or not it will work properly in any given situation.

The wheeled robot also provides an opportunity to build more complex machines than would otherwise be possible if you were limited by only using wheels on your design. For example, if you wanted something like the car instead of just a simple cart then there would have been no way for us humans (or other animals) who invented cars back then because they wouldn't have been able to afford them at all! But since they didn't exist yet we had no choice but to go ahead with building them from scratch using our ingenuity rather than waiting until someone else invented something similar enough yet better suited for our needs (Sismondo, 2018).

Another method of locomotion is legged robots. Legged robots are used in the real world to move around, for example, by walking or running. They have advantages over wheeled robots because they can climb stairs better than wheels and can jump higher than wheels. They also do not need to slow down when changing direction as much as other types of locomotion systems like wheels do because they have more control over their center of gravity (the point on a robot where the weight should be distributed).

The most common type of legged robot is called a bipedal humanoid robot that resembles humans with legs but does not have arms or hands like humans do so it doesn't require any special equipment like manipulators or grippers; however these machines still require some sort of control system such as an operator station where someone sits at all times during operation instead just relying solely upon sensors within their environment since there won't always be someone physically holding onto these machines while moving around from place-to-place within buildings among others.

Micro aerial vehicles (MAVs) are small and lightweight robots that are capable of flight by flapping their wings. MAVs can be used for surveillance, reconnaissance, search and rescue operations, military purposes, and scientific research. In recent years, MAVs have been increasingly used in civil applications such as disaster management (Alexander et al., 2006); however, they have also been utilized in law enforcement SWAT teams as well as UAVs that have been deployed by law enforcement agencies around the world including Canada, Britain, and Australia.

In the future, mobility will be a necessity. Robots are already being used in medical settings to aid in surgery and other procedures. They can also be used as assistants in the home, helping with tasks such as cooking and cleaning. The military has also been using robots for years now—the Air Force trains its pilots on flying drones using simulators that mimic flight conditions found on board real aircraft (Reeves). Robotics will continue to be an important part of our lives for years to come.

The primary goal of a mobile robot is to move from point A to point B. The robot must be able to navigate its environment, avoid obstacles and detect and avoid collisions. It has many sensors that can help it sense its surroundings including Visual sensors such as cameras or LIDARs (LiDAR stands for Light Detection and Ranging), Hearing sensors include microphones and Touch sensors include force-feedback gloves or force-sensing fingers (Shannon et al., 2010).

The importance of locomotion in robotics is that it helps us to understand how our bodies interact with the world around us, which in turn helps us to develop better ways of interacting with the world around us. This may include developing new ways for people to interact with their surroundings through technology like robots or computers.

8.5 CHALLENGES FACING LOCOMOTION IN ROBOTICS

Locomotion has been a field of study in robotics since the beginning of the field. The goal is to move a robot's body parts and joints to perform tasks such as walking, running, climbing stairs or driving. There are many challenges facing this field of research, including How to develop algorithms that allow robots to make decisions based on sensory feedback; How to build robots that can move safely around people and other objects; How to develop robots that can be used for military purposes; The lack of real-world applications for locomotion in robotics; The need for robots to be able to adapt to different situations, which can be difficult and requires a lot of work on the part of the designers and engineers behind the robots themselves(Suryanarayana et al., 2001). Robots need to be able to recognize what they are moving towards or away from for them to function properly in their environment, but this also requires a lot of processing power and energy resources from both sides (the robot and its surroundings). Another challenge facing robotic locomotion is that not all robots have feet or legs attached to them as humans do; therefore, they must use other means such as wheels and treads (or even treads without legs attached).

8.6 SENSING AND PERCEPTION IN ROBOTICS

Sensing and Perception is a field in Robotics that deals with how robots perceive their environment, and how they react to it. Sensors are the most common way of gathering information about an object or its surroundings, but they are not always enough to know what is happening around them. This is why perception is needed as well. Perception is when your brain makes sense of what it sees and interprets it into something you recognize as real. It can be very hard for us humans to understand how our brains work because each one of us has a different brain structure and different experiences, so there aren't any universal rules for understanding how we perceive things.

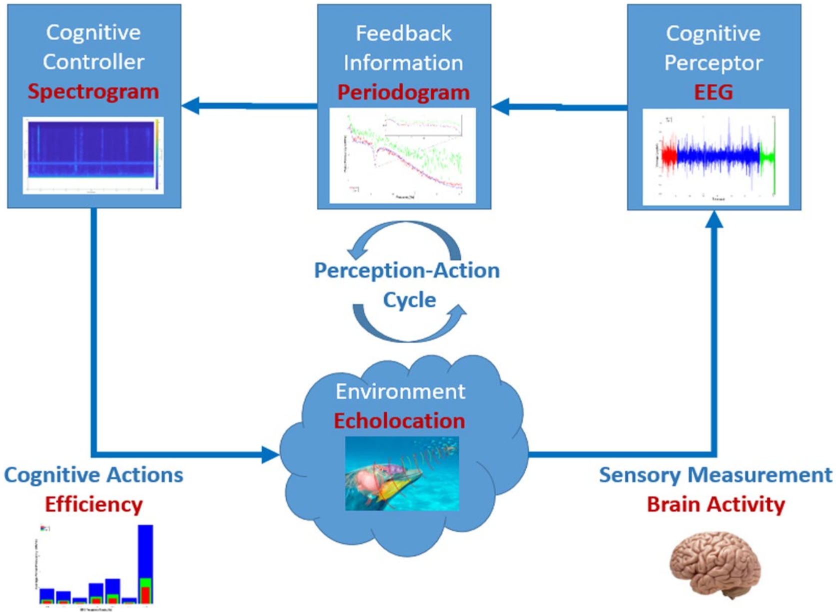

Figure 8.15: An image showing an action-perception loop.

Source: Moreno Escobar JJ, Morales Matamoros O, Tejeida Padilla R, Lina Reyes I, Chanona Hernández L, Ramírez Gutiérrez AG. Brain-Inspired Healthcare Smart System Based on Perception-Action Cycle. Applied Sciences. 2020; 10(10):3532. https://doi.org/10.3390/app10103532

Sensors are like cameras on our robot's body; they collect data about what they see and send it back to our computer so we can analyze it and make decisions based on that data. We use sensors in many different ways: They can tell if there's something nearby by measuring light levels or temperature differences between their surroundings and their bodies (so they can tell if they're hot or cold). They can sense pressure differentials caused by wind or other forces (Swierstra & Rip, 2007).

Robot vision is the process of extracting information from a video or image. This can be done by using computer vision, which involves the use of a camera to extract information about an object (such as its color, shape, and position). This information is then processed and used by other robots to navigate around obstacles or perform tasks safely. The following are some examples of what robot vision can do: Image processing: The first step in creating an image processor is taking pictures with your camera as it follows its surroundings. You may want to take several pictures while moving around so you can see how things change as they move closer together or farther apart from each other; this will allow you to make decisions on what actions need doing next based on where exactly they're located at any given time

Force and torque sensing are key components of robotic manipulation. To sense forces, the robot controller uses force sensors that measure forces on the robot's joints (Banerjee & Williams, 2013). The force sensor can be used to provide feedback to the robot controller about how much force it has applied to each joint and thus whether or not this particular movement is possible for that particular joint.

Force sensors also allow you to control your gripper arm by providing information about how much pressure you're applying when pulling or pushing something with your gripper hand. Touch and pressure sensing are important for robots that interact with humans. For example, some industrial robots need to be able to detect objects in the environment. This can be done by using touch or pressure sensors on the robot's hands or body, which then send a signal back to its brain about where the object is located. In addition to detecting objects in your surrounding area, touch and pressure sensing can also help you determine if something has happened to your own body (for example: bumping into a wall).

Range sensing is the measurement of the distance to an object. In robotics, range sensing can be used for navigation, collision avoidance, and object recognition. It's an important component in autonomous vehicles because it allows them to recognize their environment and avoid obstacles.

There are many different ways to perform range-sensing: Laser range finders are commonly used in robotics applications that require accuracy at long distances (up to tens of meters). They use reflected light from a laser beam bounced off of an object at its endpoints before measuring its distance using photodetectors mounted on either side. These devices require high-quality optics which can cost thousands of dollars each!(Small, & Klavans, 2014).

Proximity sensing is the ability to detect objects that are close by. It can be used to detect objects in the dark, in fog, and even underwater. Proximity sensors use infrared light or radio signals to determine how far away an object is from the sensor. The closer an object is to your robot, the more likely it will be detected by your sensor system.

Robotics is a field of engineering that deals with the design, construction, operation, and application of robots. Robots are used in manufacturing; medicine; research and development; education; entertainment and other fields. Robotics has been around for many years but it’s only recently that sensors have become cheap enough to be used by hobbyists or students (Badgujar et al., 2008). Sensors in robotics come from different sources such as optical systems (laser range finders) or digital cameras (for example). You can also use other types of sensors such as magnetometers which measure magnetic fields around your robot’s body or accelerometers which measure acceleration forces acting on its body (elevation changes). In addition to sensing data from these sensors, you might also need information about where exactly you’re at so you can determine what direction something is facing when viewed through an attached camera lens such as those found on cellphones today.

CHAPTER 9

THE IMPACT OF VIRTUAL REALITY ON EDUCATION

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Virtual reality technology has the potential to profoundly change the experience of learning in education. It could help teachers engage their students more fully and realistically, making them more comfortable in new and challenging environments. The impact of virtual reality on education is so profound that it is often referred to as a second wave of computing after the invention of the internet (Web 2.0) or mobile phones (Web 3.0). It is indeed the next frontier in technology, offering an immersive experience unlike any other. As a result, it has opened doors to new possibilities for education and research. From a young age, we are all exposed to technology (Rogers & Marres, 2000). The entrance of virtual reality into the education sector is undoubtedly one of the most significant global technological breakthroughs in recent years. With its limited use and accessibility, it is estimated that this figure will increase substantially within the next decade.

Figure 9.1: Virtual reality has and is continuing to revolutionize education and the sector as a whole.

Source: Image by Open Access Government.

Virtual reality is a computer-generated simulation of a user's physical environment. It can be used to create, experience and provide feedback on virtually any environment, creating detailed simulations. Virtual reality uses three-dimensional graphics, motion tracking, and advanced haptics to create an interactive and realistic experience for the user. Virtual reality has been around a while now. However, the technology has only recently begun to reach the education market.

Virtual reality is already playing a big part in education. At the moment it is largely used as an object to study and practice, but as we become more familiar with this technology, it will become important in learning how to use virtual environments for education. The impact of virtual reality on education is far more than just a technological advancement. It has the ability to change how we absorb and engage with information, how we perform our daily activities and how we travel through space. Today, virtual reality is seen as a potential to transform many aspects of education (Rao & Cheetham, 2001). It may help us to better understand our own minds and those of our students, improve our communication skills, and reduce stress in schools.

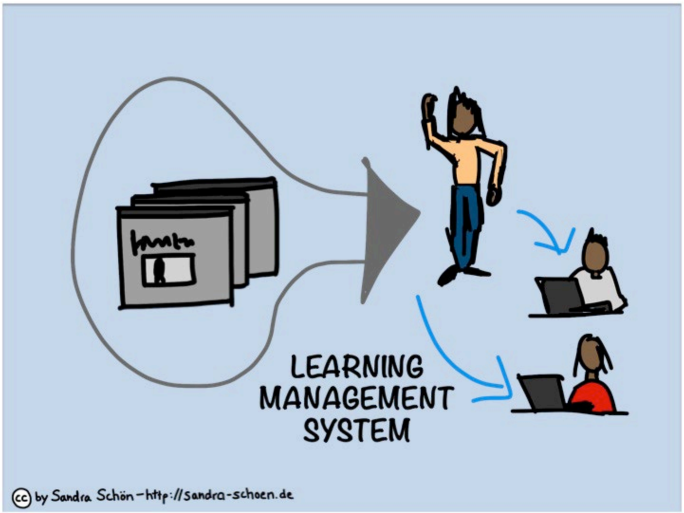

Figure 9.2: Although developing, students today receive a new immersive and unique experience that has made education easier.

Source: By Sandra Schon - https://www.flickr.com/photos/24120891@N02/13621994315, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=102561078

It is to be noted that the use of VR in education is still in its early stages due to the numerous challenges associated with it. Moreover, there are also several ethical questions that need to be addressed before any such use can become possible. These include whether teachers will be able to assess or enhance student learning through virtual experiences; whether children will be exposed to potentially addictive content; whether these experiences might impact their mental health in a negative manner; and what role do parents play when it comes to choosing these types of educational tools for their children.

The technology provides unique experiences that can contribute to its growth as an educational tool in many ways: learners enjoy new learning possibilities and amplify their potential through immersive environments, teachers can improve their knowledge and skills, students have more opportunities to learn and progress in their learning process with the help of VR devices. As one of the first use cases that introduced us to the concept of a digital ecosystem, VR leverages the benefits of being able to create environments without a physical setting (Porada et al., 2013). Since 1999, VR and AR have been used in training and education by companies like Bull horn and PTC, but with so many virtual worlds available today, students no longer have to go through "training wheels" for technology. This explains how VR can be used to supplement or replace real-world experiences and live projects.

9.1 THE PHASE OUT

With the ever-increasing popularity of virtual reality education and gaming, many educators see this as an opportunity to make learning more engaging - and a platform to motivate students to learn. But are VRs really a suitable replacement for traditional forms of learning? What does the future hold for virtual reality? More parents are embracing virtual reality as a way to monitor their children, keeping an eye on their behavior in school and at home (Pahlavan & Makela, 2002). With virtual reality, you can interact with other people over the internet through your computer. However, this technology has drawbacks because it requires the use of powerful computers and monitors.

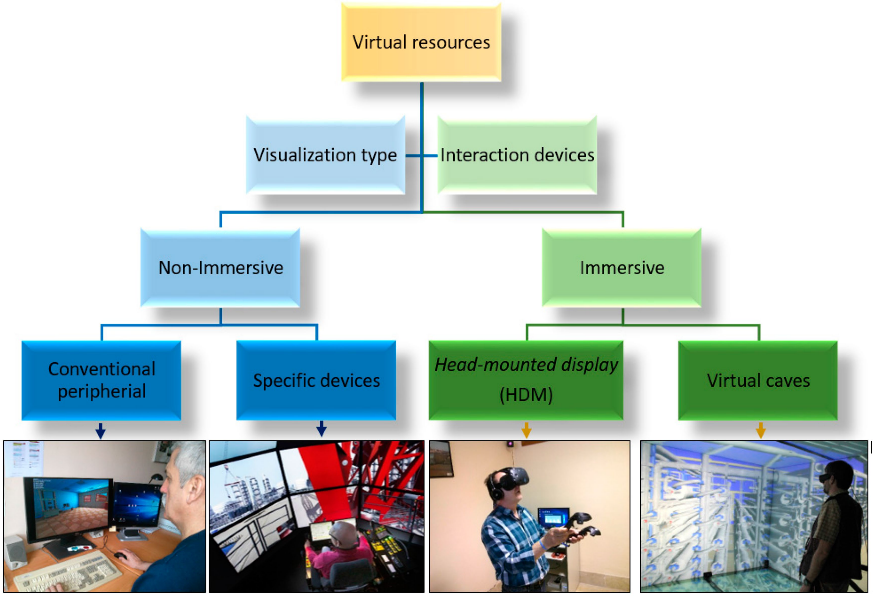

Figure 9.3: The development of virtual reality and how it has come to impact education.

Source: Vergara D, Rubio MP, Lorenzo M. On the Design of Virtual Reality Learning Environments in Engineering. Multimodal Technologies and Interaction. 2017; 1(2):11. https://doi.org/10.3390/mti1020011

The use of virtual reality in education is making the difference between learning and forgetting. It gives students a comfortable and safe way to learn. Students can participate in real-time with teachers and other students, experience different environments and explore new things that would be hard for them in real life (Bøe et al., 2011). Teachers will be able to communicate better with their students through this technology. This can also result in more inter-personal communication among students, as well as make them more aware of social issues.

Students can have a better understanding of the subjects they are studying with the help of this technology. With a virtual reality setup, students can feel like they are actually in the place where they're taking their course. There will be major changes in education with the implementation of virtual reality since it is a very interactive way to learn.

9.1.1 Creating Immersive Senses of Place and Time

Virtual Reality is changing the way we interact with the world around us. It creates immersive senses of place and time, opening new opportunities for education. Through its definition, it is a digital interactive system that creates immersive senses of place and time. Schools can use virtual reality to teach children in classrooms by engineering spaces that make the learning experience as lifelike as possible, such as inventing new smells or sounds within the rooms. Virtual reality can help overcome some of the difficulties of traditional distance learning experiences. In virtual reality, like other immersive technologies, students are able to experience a sense of place without leaving their homes or classrooms.

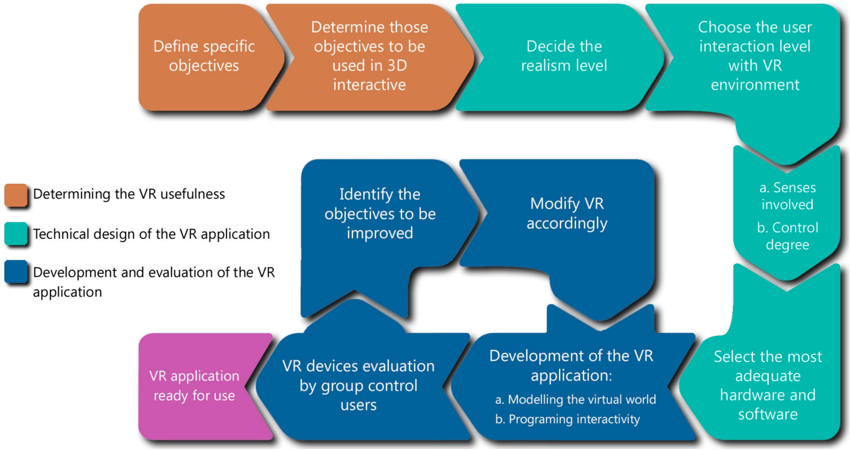
Define specific objectives
Determine those objectives to be used in 3D interactive
Decide the realism level
Choose the user interaction level with VR environment
a. Senses involved
b. Control degree
Select the most adequate hardware and software
Development of the VR application:
a. Modelling the virtual world
b. Programing interactivity
VR devices evaluation by group control users
VR application ready for use
Identify the objectives to be improved
Modify VR accordingly
Determining the VR usefulness
Technical design of the VR application
Development and evaluation of the VR application

Figure 9.4: Through virtual reality, students have a real-time view of particular case studies.

Source: Vergara D, Rubio MP, Lorenzo M. On the Design of Virtual Reality Learning Environments in Engineering. Multimodal Technologies and Interaction. 2017; 1(2):11. https://doi.org/10.3390/mti1020011

Education, especially in the STEM fields, is becoming more immersive with virtual reality. Students will be able to feel and experience what they are learning because they can have their own home base so they can work at their own pace. Interacting with other people who are also in the same room instead of on a computer makes it very exciting for students who rely on others for help and feedback. Remote users such as teachers and mentors can join in on these activities so it is not just student driven learning.

Virtual reality creates immersive senses of place and time that can help people learn, problem solve or get a better understanding of their childhood. In the classroom especially, VR can be used to demonstrate concepts like how two-dimensional objects are perceived in three dimensions. This can benefit hardworking students who need extra time on tests or may have a visual impairment when it comes to solving math problems for example (Otsuka & Kakeshita, 2002). Virtual reality will be taking over the education space more in the future as immersive technologies become more accessible, user-friendly and affordable.

Creating an immersive sense of place and time can be achieved by letting the user move in different locations, which would allow him or her to learn faster, especially when it comes to geography and history. VR also has the ability to provide a realistic experience, which could help students be motivated in learning more about foreign cultures as it stimulates empathy and interest. Virtual Reality (VR) has been used to create immersive – sensory experiences that allow users to experience a natural environment as realistically as possible. This can be done through both 360-degree video footage and holographic technology. By using VR, educators can provide students with more immersive and engaging experiences while also improving the focus on their grades.

Virtual reality technology allows users to be in a variety of places, at many different times in history, and interact with people who are real or imagined. For example, when viewing a 360-degree panorama clip, users can see themselves as though they were actually standing on the ground in front of an ancient ruin. Unlike conventional films or paintings that depict subjects from a single perspective, virtual reality presents viewers with a complete view that places them inside the scene t multiple times during its production process (Nisbet et al., 2002). This makes it possible for students to experience a variety of educational experiences from multiple points of view without ever leaving the classroom.

9.2 APPLICATION IN DIFFERENT FIELDS

Virtual Reality is utilized in many educational practices in order to help people understand the importance of exploring places beyond the confines of their own homes, local schools have also incorporated VR technology into their curriculum which allows students to learn through immersion. Many schools and universities have been using it to create immersive senses of place and time to support the curriculum and increase engagement. VR has many advantages, including making learning more enjoyable and tangible, creating a memorable experience that's difficult to forget and giving students a sense of feedback much earlier in the process.

For example, research demonstrates that geography students who have experienced virtual worlds can recall them more vividly in their minds, which creates a more vivid sense of location and time during lectures/tutorials. This is the basis of virtual environments. Virtual reality is sometimes called virtual environments, immersive environments or simulated environments (Bernardes & e Albuquerque, 2003). The term virtual reality describes the ability of users to interact with a computer-generated sensory world where what a person sees, hears, feels and wears is not only different from the real world but also can be designed to influence how one's brain interprets the environment.

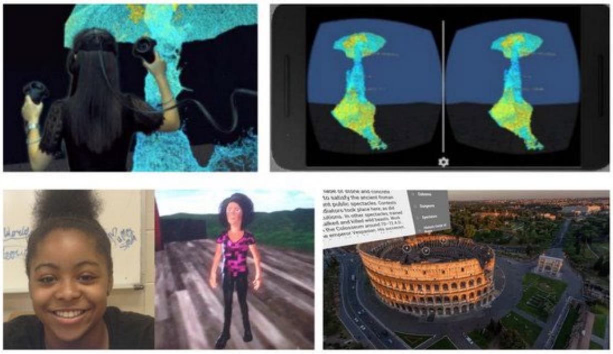

Figure 9.5: Virtual Reality can be applied in various fields of the education sector.

Source: Kamińska D, Sapiński T, Wiak S, Tikk T, Haamer RE, Avots E, Helmi A, Ozcinar C, Anbarjafari G. Virtual Reality and Its Applications in Education: Survey. Information. 2019; 10(10):318. https://doi.org/10.3390/info10100318

By using virtual reality applications maths is being reimagined as a social pursuit rather than an objective construct about numbers, lines and shapes. In a research conducted on mathematics, subjects were asked to complete a mock university admissions test involving various situational problems in maths while practicing with a virtual environment and receiving feedback as they progressed through each stage. The authors showed that there was an improvement in cognitive ability, memory, mental flexibility and planning ability. Furthermore, students that were able to complete the task were more likely to achieve high marks on their final exams compared with those who did not complete the task.

9.2.1 Implementing a Virtual Reality Based E-Learning Environment

Virtual reality (VR) based e-learning environments are an interesting concept. It provides a new way of teaching and learning without the physical presence of the students or teachers. VR technology is still in its infant stages. The impact of using this technology will no doubt be exponential, given that it holds endless possibilities both socially and academically. As technology becomes more advanced and accessible, it will impact many areas of learning which include innovation, community engagement, social interactions, and instructional design or delivery (Breschi & Catalini, 2010). A virtual reality based learning environment will allow students to immerse themselves in content through a variety of experiences that will take full advantage of the human brain's ability to create memories, retain information, and adapt.

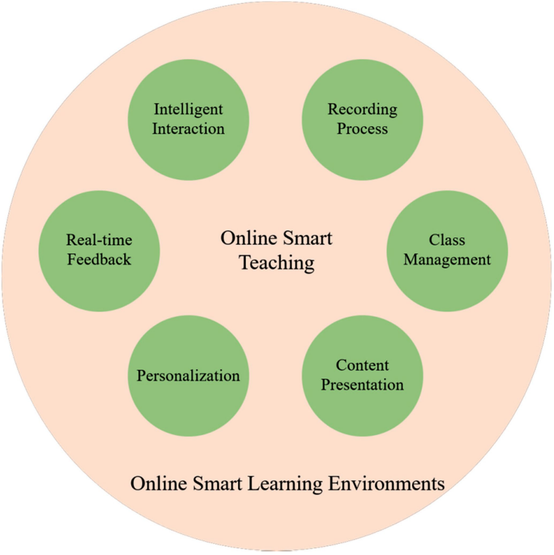

Figure 9.6: Necessities in the creation of an e-learning environment.

Source: Wang S, Shi G, Lu M, Lin R, Yang J. Determinants of Active Online Learning in the Smart Learning Environment: An Empirical Study with PLS-SEM. Sustainability. 2021; 13(17):9923. https://doi.org/10.3390/su13179923

From enabling students to learn and retain information better than ever before, to providing opportunities for on-campus study, virtual partnerships with international institutions, industry and non-profit partners have accelerated the realization of what VR can do for education. Virtual reality is a great learning tool, but the use of virtual reality depends in many aspects on how it is implemented. The performance and effectiveness of this type of teaching and training must be based on an application that includes adequate and appropriate spaces and equipment, as well as the methodologies used by the instructor to best fit the target audience.

Learners will be able to interact with Virtual environments, either as a student or teacher. Expanding STEM to include VR as a new learning platform will help students view their subject matter or content in a different context, which helps them see their lesson through a different lens. And by creating real-world applications for VR, students receive the motivation and reassurance that they really understand what they learned in class. A recent study by Chapman and Coverdale explored the use of virtual reality in education. The study was a systematic review of the literature that focused on the assessment, evaluation and treatment of mental illness in children and adolescents (Moore, 2013). The review analyzed virtual reality's role in assessing emotionality, social competencies and self-regulation skills, as well as helping individuals understand how their strengths are relevant to learning. They discovered that virtual reality had a significant impact on improving the biological factors that affect our behavior.

9.3 THE SOCIAL POSSIBILITIES

In the past 2 decades, social learning tools like Virtual Reality have been added to the e-learning environment. The unique and interactive nature of VR can help students improve their interaction skills, and communication skills to create an immersive virtual world that empowers them to freely express themselves and have their own social experiences.

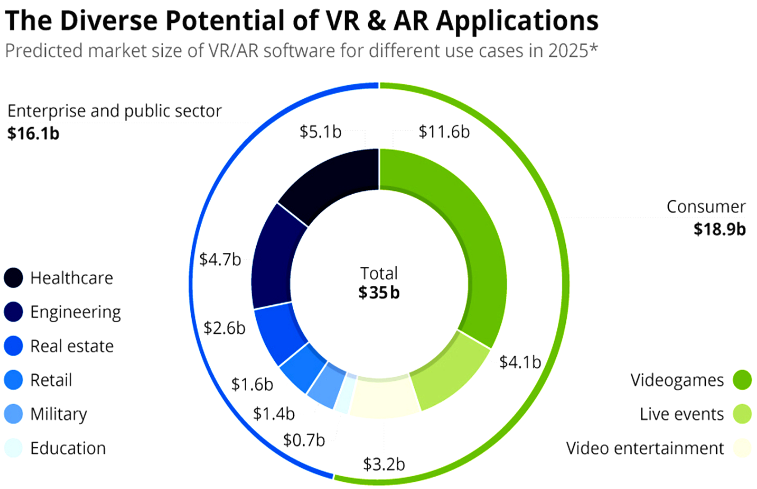

Figure 9.7: The potential of virtual reality in various fields through education.

Source: Image by the World Economic Forum

Technology and education have always gone hand in hand. In today's world, technology is becoming more advanced every day, making education more accessible and effective for students. Virtual reality offers educational opportunities that no other medium can match, allowing students to have virtual experiences from their homes too. The opportunities to shape the future of education lie in its use. Virtual reality triples the amount of information that students can process at any one time and allows them to learn in a way that best augments their productivity and performance (Bengisu & Nekhili, 2006).

With the use of VR systems, students can practice conversations in a social environment over video calls with their virtual counterparts, or to watch their favorite television shows while they learn. The dawn of virtual reality signals an exciting time for education; students will be able to engage with anything they wish based on their interests and hobbies, shifting the focus away from textbooks and teachers as a whole.

9.4 THE EDUCATIONAL POSSIBILITIES

The impact of virtual reality on education, particularly for educators and students alike, is that VR content can be used as an alternative and additional form of learning. The possibilities offered by an immersive educational environment such as VR are not only for entertainment but can also provide a more immersive experience for both learners and instructors. Virtual reality is set to revolutionize education by providing new learning opportunities (MacIá, 2005). The immersion into the virtual world allows students to project themselves as they learn and adjust their knowledge to the situation of their choice. This digital learning environment allows teachers to provide alternative learning experiences that are impossible with traditional methods even with increasing use of technology in classrooms.

9.4.1 Key Elements Of Virtual Reality That Promote Learning

Virtual reality offers an immersive, yet fully hands-on experience that ends up being more effective than traditional forms of learning such as lectures and textbooks. Because of its immersive nature, VR allows students to challenge themselves in new ways and explore concepts throughout the creation of a virtual world that can be manipulated with the use of pre-planned learning pathways. By applying teaching techniques used in virtual reality environments to conventional methods, teachers can help students practice problem-solving skills and spatial orientation while simultaneously improving hands-on learning activities within real life classrooms (Martin, 2010). Besides this application through academic settings, we can also see applications in training programs by enhancing current methodologies used when developing robotic prototypes or equipment based on simulated simulations.

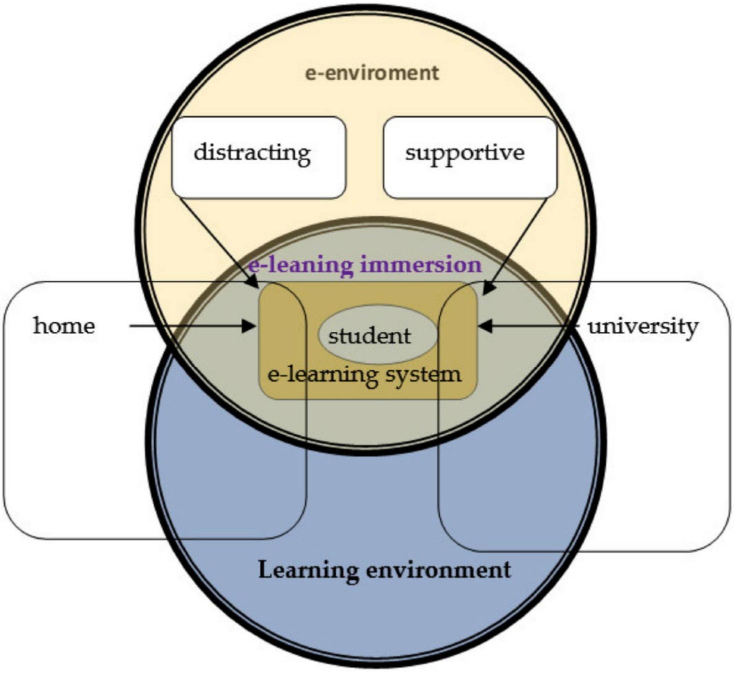

Figure 9.8: There are a number of elements that incorporate virtual reality and its application in learning.

Source: Bylieva D, Hong J-C, Lobatyuk V, Nam T. Self-Regulation in E-Learning Environment. Education Sciences. 2021; 11(12):785. https://doi.org/10.3390/educsci11120785

The overall experience that can be created by virtual reality is to provide a sense of presence and physicality, even when the user is not in motion. Elements such as sight, sound and touch are important for ensuring engagement. Research studies show that VR applications are able to stimulate one of the most powerful learning systems in the human brain – our neocortex. This is also because VR embraces two important qualities of human culture: identity, or your sense of self; and storytelling, or communicating about yourself through words.

The key elements of virtual reality that do promote e-learning are totally based on the type of virtual reality in question. The most common types of virtual reality used in education are the virtual world and augmented reality. More recently, VR has become a popular medium for learning, both as an educational tool itself and as part of more traditional educational programs.

Further breaking down details that there are three main types of virtual reality have been used to deliver learning content in higher education: Full Motion Video (FMV), Virtual Reality Game (VRG) and 360-degree videos (Liu & Zhang, 2011). The use of FMV has grown in popularity since the 1980s and is used today for both learning, assessment and a variety of other purposes.

Then there is the non-immersive virtual reality. The application of non-immersive virtual reality in education has been growing at a strong pace. Its applications are vast and the possibilities are endless. The main reason for this is that it is the next major step when teaching, learning, and having fun in education. Not only does it allows students to engage with the subject matter more thoroughly than before but also allows more time for deeper learning.

Non-immersive virtual reality is actually a way of producing realistic three-dimensional computer graphics which can be explored in a variety of ways. The user has the freedom to move around and explore virtual environments, using the device as if it were really there. Non-immersive virtual reality applications are widely used for training and education, but also have important uses in research and development and many other areas of application. It is an umbrella term used to describe a range of technologies that leverage the power of the human senses. These technologies include head-mounted displays, motion capture, and haptic feedback, which combine to create a fully immersive experience that enables users to interact with digital objects in a natural manner (Lieber, 2003). Non-immersive virtual reality not only provides a new way for users to experience digital content, but also provides opportunities to help learning in classrooms by leveraging them as tools for interaction and interaction design.

As an example, a reduced-cost and space-saving method of creating non-immersive virtual reality experiences, the Oculus Rift DK2 can be used to produce visualizations that can be viewed on a desktop computer, laptop or mobile device. The headset uses low frame rate displays to create a feeling of immersion by not rendering graphics at a greater than 60 frames per second. Then there is the semi-immersive virtual reality. Semi-immersive virtual reality is used in the education field to create virtual environment that allows students and teachers to interact with the environment without leaving their seats.

The use of semi-immersive virtual reality (SIVR) in the education sector can help transfer knowledge and skills from classrooms to the real world.

It is a low-cost, high-impact way of learning and teaching. SIVR allows students to experience new worlds while they learn and also makes classroom activities more engaging and relevant through contextually simulated environments. Semi-immersive virtual reality (SIVR) is an emerging educational discipline that blends VR, AR and mixed reality technologies to create lifelike immersive content that provides a new user interaction paradigm. It represents a mixed reality system that uses head-mounted displays and other devices to transform a user's physical environment. It was originally developed to provide a lifelike experience to support training in medicine, dentistry, nursing and other healthcare professions (Bell & Lederman, 2003).

Finally is the fully-immersive virtual reality. The application of fully-immersive virtual reality in education offers a great platform for exploring the world around us. With infinitely interactive content and a zero-gravity interactive teaching environment, the possibilities are endless. There is a great deal of interest in the application of fully immersive virtual reality in education. It is often viewed as an innovation that can be used for distance learning, for assessment and for use in the healthcare field.

Fully-immersive virtual reality (FIVR) is a form of computer-based education that allows students to experience the world as they would normally, while interacting with it in real-time. By immersing the learner in an environment where they can learn and interact with digital content, FIVR creates an immersive educational experience that exceeds live-classroom activities. No matter what subject you teach, FIVR provides access to the information and ideas that students need to make informed decisions in a highly complex world.

9.5 KEY ELEMENTS OF VIRTUAL REALITY EXPERIENCE THAT PROMOTE E-LEARNING

9.5.1 The Virtual World

The Virtual world is the Internet, which is a network of computers that allows you to access the Internet. It includes a virtual keyboard, location and identity tracking, news feeds, e-mail and instant messaging services. It is a term that has been used in computing to describe the Internet, an idealized digital space in which one could interact with other computers and people and share information with them. This can be done through the use of email, websites and instant messaging (Liu & Ihl Woo, 2006). The full effect of the virtual world becomes apparent when we realize that it is possible to create a totally new character, who may or may not have existed before we logged on and made him or her 'alive'. It is also possible to influence real life events through our choices in this virtual world because they are translated into facts that spread online like viruses.

Figure 9.9: The virtual world represents a digital space where one can view and obtain anything he/she wishes for.

Source: By ESA, CC BY-SA IGO 3.0, CC BY-SA 3.0 igo, https://commons.wikimedia.org/w/index.php?curid=62840930

The virtual world is in a linear fashion where all things happen as one. It is tangible and real, but also a dream-like place.

Features

The virtual world is a place where we can do things that are not possible in the physical world. In fact, it is where the virtual world is used for education. As such, the virtual world can be characterized by a number of different features, including individualism and interactivity. The virtual world introduces students to the potential of 3D interactive environments, which promotes an increase in focus, attentiveness and memory. The virtual world offers a variety of tools and mechanisms that may help improve learning outcomes in terms of sharing information, techniques and skills through simulation (Kobayashi et al., 2019).

It represents a stage where students can take their learning experience beyond the walls of the school. The virtual world can be used as a platform to learn, help build community and character, and improve communication skills and many other purposes. As the virtual world becomes more pervasive, it has become increasingly important for educators to consider how VR can be used in their classrooms. In the virtual world, individualism is defined as the act of enjoying oneself. In the education industry, this means that learning is taking place on an individual level instead of through group learning.

Figure 9.10: It is in the virtual world that children can easily build and virtually automate.

Source: Image by World Education

It is a way of life that attracts individuals who want to be free from the constraints of reality, it can also be used by organizations to provide groups with a sense of community and belonging. The education industry has been challenged for decades to create a sense of individualism in students. The system of education today does not sufficiently meet the needs or aspirations of students as it continues to be focused on traditional methods such as pen, paper and chalkboards with little emphasis placed on learning through technology.

The education industry, much like our real world, considers individualism to be an important factor in success. Students and employees should be allowed to make decisions as to how they want their time spent. Employees should have the freedom to work in the way that best suits them, whilst still meeting the needs of their organization (Howe-Walsh & Turnbull, 2016). Interactivity on the other hand allows for students to participate meaningfully with the teacher and curriculum.

The virtual world enables teachers to incorporate the latest interactive technologies and lessons into their teaching. This is done primarily through a simplified programming interface that allows teachers to add more content, manage students' logs and interact with parents in real-time. Observation is also possible, allowing teachers to see what their students are doing in real-time to ensure that learning is not disrupted by excessive noise. With the help of the virtual world, it is possible to develop a classroom scenario on a large scale. It can be an effective form of development for students as it helps them to understand the context based on them. The Virtual World also helps students to learn multiple subjects at one time.

Benefits

The virtual world has been applied in the education industry. The most obvious advantage is to provide learners with a platform that allows them to access information on any subject matter, anytime & anywhere. A virtual learning environment promotes flexibility, as well as an improved learner experience by enabling employers and educators to gather feedback on student achievement. The virtual world has emerged as an important tool in developing and promoting the skills of a global market. It is not only popular among young adults but also can be applied to adult learners (Hagendijk & Irwin, 2006). The virtual world presents an advanced environment, allowing learners to learn in various ways and at any time, depending on their age and other factors.

It has been proven in many studies that the virtual world can help people with mental illnesses. The use of such programs has been beneficial to the students during their time out of school. The virtual world allows students to completely isolate themselves from the real world and focus on one subject at a time. This provides them with necessary time over their peers that are also learning at the same time. Students can take practice tests and lectures, receive feedback and assessments, collaborate with others as well as learn more independently by working through problems together (Granato et al., 2014). These all help to enhance their chances of passing the course successfully, allowing them to graduate with a degree that carries with it benefits beyond their diploma.

9.6 REASONS FOR THE RAPID GROWTH OF THE VIRTUAL WORLD

There are many reasons for the rapid growth of the virtual world as applied in the education industry. In this world, students who seek a better education but can't afford it are encouraged to not only access the material they need but also learn how to design, develop and test their own programs. There is no risk of failure or missed classes because a student can simply study at their own convenience and rate their own progress through a customizable 'learning log' which measures everything from quiz grades to programming skills. Students can challenge each other to see if they deserve a prize or feel like they will be truly ready depending on how they perform.

It is attributed to several aspects such as its ability to make learning more interactive, fast and effective. With this, it can be widely accepted by students, teachers and educators as well as parents who want their children to benefit in an interactive way (Borup et al., 2006). Certain factors are driving the growth of the virtual world in education, such as: Need for measurable progress towards higher learning goals, increase in accountability and transparency, and ongoing improvement in student learning outcomes.

9.6.1 Paths Open

Today, there is no single method for content generation and dissemination. There are numerous ways to effectively integrate virtual worlds with other technologies, including electronic learning management systems (e-learning) and mobile learning applications. In the education industry, employees can choose from a wide array of relevant training paths. Virtual world is becoming an increasingly important part of the work life, especially for those working in higher education or with international students. While there are limited options currently available, opportunities to gain experience in virtual worlds are increasing rapidly.

9.6.2 Immersion

Immersion is a technology that utilizes the virtual world to ensure the best possible learning experience for each student. Immersion allows students to study through various video games, simulations, and 3D environments that offer learning opportunities in the field of education. It refers to the process of merging one's actions or thoughts into another reality(Chadwick et al., 2011). Immersive experiences are a special type of stimulation that allows users to vicariously live life in a computerized virtual world. Immersive plays can teach students important life lessons by using an engaging and immersive technology in a safe environment.

Figure 9.11: Immersion allows students to gain knowledge through video games, simulations and 3D environments.

Source: Image by Wikipedia

The use of technology to enable the delivery of education and training, in a non-traditional manner, has become an essential element in the design and delivery of an effective learning process. Immersion enables learners to connect with information through a personal computer console, or some other portable or local device. While many people have used immersion in their efforts to deliver educational content, it is only recently that the concept has been applied to digital content.

9.6.3 Video Games

The idea behind immersion is to focus on the learner and his/her ability to be immersed in a virtual environment. This can be achieved by having 3D technology offer real-life representations or manipulate video frames (Image sequences) to recreate real-world scenarios. The idea of virtual reality is that it can recreate scenarios that are close enough for both sides to understand, but at the same time distant enough for them to have new constraints with information and understanding that can only be obtained from applying context cues. Research shows that some of these use cases include: entertainment (gaming), education (museums, simulation labs), training simulation, and healthcare applications (Grupp & Mogee, 2004). Immersion is a video game model that uses a combination of approaches including: sensory, interactive, and communication. The goal of immersion is to foster the development of language and cognitive skills, as well as emotional state.

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Figure 9.12: Video games are some of the most widely known mechanisms of virtual reality widely used in modern society.

Source: By gwaar - Flickr, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=4345129

9.6.4 Simulations

Immersion is a development method which involves the use of simulation software to provide an immersive environment to experience new and challenging ideas. In this way, it uses virtual environments using 3D graphics, sound, and motion in combination with virtual objects. Immersion applications have been used in educational settings for a variety of purposes including training for technology-based professions such as electrical engineering (#EE), medical imaging (#IME) and mobile app development (#SIM). However, the majority of simulations used in education are based on video game logic, which can result in poor retention by students. In this research, we aimed to explore whether an immersion environment at the highest level of realism could improve learning outcomes by using sufficiently cost-effective technology such as low-cost headsets and motion sensors. A spatial augmented reality (AR) system called Immersion was tested to train healthcare workers in radiology. Training was divided into four phases: control with visualization only; control with head tracking only; control with both head tracking and visualization; and an immersive training phase (Immersion). After testing six participants on their first day at work, they performed a four examination workload--10 exams without distraction or multitasking--on subsequent days until fatigue set in (Gandini, 2011). They found no performance differences among conditions during quiet reading ($p > 0.05$). However, they did observe a significant difference from baseline when multitasking compared to a single task ($p < 0.001$).

9.6.5 Sensory Feedback

Sensory feedback, also known as interactive response technology or IR, can be applied to a number of applications in virtual reality and robotics. A major benefit of these technologies is that they provide direct feedback to the user without interrupting their experience. The concept of sensory feedback is an important pillar of VR in the educational sector. It may be used to enhance the experience and to develop self-regulation, among others (Cao et al., 2006). The need for sensory feedback is part of the learning process, it is an essential element of learning. The use of sensory feedback in educators means that children get to feel what they do with good results, this means that their abilities and learning capacity improve as a result. This can be implemented via VR technology but also with other formats such as augmented reality which creates applications in a virtual environment such as a smartphone or computer screen.

Sensory feedback helps teachers to give students information about their performance, as well as learn without being forced or invasive for them. Virtual reality is used in the educational sector to create a sense of presence. Sensory feedback is used to increase the interest and involvement in the students. A growing number of research papers have examined the value of providing users with different types of virtual reality feedback. These studies are focused on a growing body of work that looks at the sensory experience as a method for delivering educational content. Although this approach has been taken into consideration as part of many Virtual Reality Immersive Environments (VRIs), it is not yet implemented in educational institutions. Research seeks to provide practical recommendations on how this method can be implemented in education (Ferrari et al., 2015). A key feature of VRIs is their ability to deliver a rich type of sensory feedback to learners, allowing them to interact with the environment by manipulating stimuli. In order to accomplish this aim, however, the underlying architecture needs to be carefully designed with particular user profiles in mind. The experience of virtual reality is influenced by more than just sensory inputs. The way in which a virtual world is experienced depends on the type of visual, auditory and haptic feedback provided to the user. Sensory-based learning designs in virtual reality (SBLR) have many advantages over traditional approaches to SBLR, including more opportunities for subjects to learn about other subjects, enhance communication skills and overall engagement. These additional benefits may increase interest in the subject and therefore improve retention.

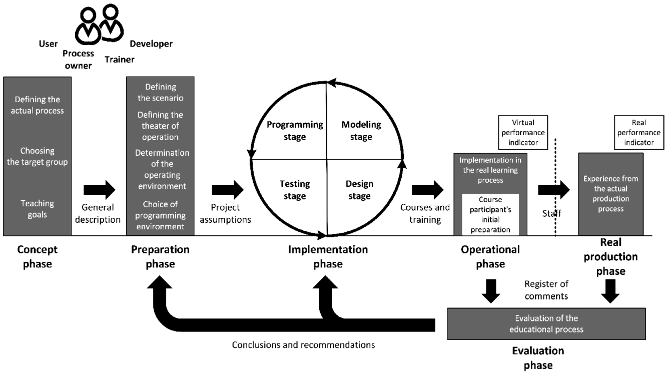
User
Process owner
Trainer
Developer
Defining the actual process
Choosing the target group
Teaching goals
General description
Defining the scenario
Defining the theater of operation
Determination of the operating environment
Choice of programming environment
Project assumptions
Programming stage
Modeling stage
Testing stage
Design stage
Courses and training
Virtual performance indicator
Implementation in the real learning process
Course participant's initial preparation
Staff
Real performance indicator
Experience from the actual production process
Concept phase
Preparation phase
Implementation phase
Operational phase
Real production phase
Register of comments
Evaluation of the educational process
Conclusions and recommendations
Evaluation phase

Figure 9.13: Various sensory impacts of virtual reality.

Source: Paszkiewicz A, Salach M, Dymora P, Bolanowski M, Budzik G, Kubiak P. Methodology of Implementing Virtual Reality in Education for Industry 4.0. Sustainability. 2021; 13(9):5049. https://doi.org/10.3390/su13095049

Virtual reality is a natural solution for enhancing the experience of children in their learning environment. Through the use of VR-ready hardware and exclusively adapted software, children can not only enter virtual worlds but also become active agents within them. This approach helps to remove barriers that typically limit children's free exploration. The educators need to understand the learners' experiences, understandings and experiences from their perspective in terms of sensory feedback in virtual reality. If we fail to do so then it will be impossible for us to understand what the learners want and how can we prepare material that conveys these ideas in a manner that is meaningful to them.

The use of virtual reality (VR) technology in the educational sector has been gaining in popularity over the years. This is largely due to its ability to offer immersive experiences and encourage more direct user participation, which can help learners develop a greater understanding of a topic as well as improve their emotional memories associated with it (Doi, 2006). But there are also drawbacks associated with using VR technology in education; for example, there's no way for learners to experience real-life situations outside of their own homes, and if used without any extra focus on learning or development, VR could become boring and ineffective due to lack of engagement. However, these issues can be overcome through the use of sensory feedback.

9.6.6 Interactivity

Interactivity is the primary element of virtual reality in the educational sector. Learning-based exercises, opportunities that make the use of authentic experience, and interactivity are used to facilitate the learning process with a new vision of pedagogy. Research works on interactive virtual reality applications in education and discusses different forms of interactivity in several aspects (Ferguson & Zhang, 2002).

Interactivity refers to the ability to touch, hear and see with one's body and perception systems through physical interactions with or without specialized hardware. The basic idea is that when it comes to learning there should be a closer connection between the learner and the subject. Interactivity allows people to gain deeper knowledge about a subject because they can decide which information they want to learn as well as find visual feedback from the computer screen on their faces. "The process of creating a simulation is not different from creating any other program. The only difference is the interface" (Sven Seidel).

Figure 9.14: Interactivity is an element that allows one to touch, sense and hear various activities.

Source: Image by Freepik

Highlighted by the ability to engage users in three directions and 360 degrees through realistic movements, interactivity and visual qualities of a virtual environment – is the key element of all VR experiences. Interactivity can be made available to learners in various ways, either directly or indirectly through interaction with real-world content. Movement, touch, sound and other stimulation comprise the interaction mechanisms for virtual reality (VR). In a proposed framework for VR development, some interaction design elements were identified and presented as challenges for VR applications as a new tool for teaching students from different educational backgrounds (Floros et al., 2010). The missing elements are motivation, attention towards the exploration of new learning environments by many learners with varying difficulties level, effective instructional message presentation, and fast transition between instruction and interpretation needs during an active learning process.

In addition to basic textural experiences, the digital world makes use of other senses such as auditory feedback or haptic feedback. Interactive virtual reality platforms can provide a wide range of sensory perceptions in a very dynamic way. In addition to interactive web games, different kinds of interactive experiences may be developed that emphasize one sense over another. Virtual experiences can be created for use with 3D audio systems and both active and passive haptic devices, such as force feedback devices. The main goal of interactive virtual reality is to communicate the concepts and processes. Interactive virtual reality is defined as a medium for communicating information about a subject by using 3-D models, video and audio. The goal of interactive virtual reality allows users to actively use the technology, which allows them to take part in various programs.

Interactive objects as a design and programming principle in open-structured virtual reality environments is increasingly studied by researchers. Interactivity plays an important role in the creation, adoption and growth of virtual reality technologies as they are being affected by the presence of real people. People who use VIRTUAL reality will rely on this interaction to make sense of their experience (Dhillon et al., 2017).

9.6.7 Comfort

Comfort as an element of virtual reality in the educational sector is one of the main goals for which a wide range of virtual reality technologies and products are being developed. Comfort is important in educational activities, so it's necessary to take into consideration individual comfort, as well as the comfort within groups and collectives. Studies conducted on comfort during studies at university show that it is not just about physical comfort but also about mental relaxation, which can provoke positive emotions such as joy or happiness. Comfort during learning leads to better results and satisfaction during activity.

Figure 9.15: Comfort is a necessity for an effective virtual reality experience.

Source: Xing Y, Liang Z, Fahy C, Shell J, Guan K, Liu Y, Zhang Q. Virtual Reality Research: Design Virtual Education System for Epidemic (COVID-19) Knowledge to Public. Applied Sciences. 2021; 11(22):10586. https://doi.org/10.3390/app112210586

Comfort is an important factor when it comes to virtual reality in the educational sector. When wearing a virtual reality headset, you need to be able to fully experience your surroundings. If your view isn't clear because of uncomfortable headgear, or if you feel too hot or too cold, you won't want to use VR anymore! The research about the use of VR technology in education is still in its infancy. However, a number of studies are already available on how VR can be successfully applied to effectively improving learners' experiences and teaching skills. One interesting way is to provide students with sensory feedback (Foest et al., 2006). As useful as this element may be when learning a new language or memorizing a lesson, it could also play a crucial role in providing students with the reassurance they're doing well during long hours of studying, rehearsing or performing exercises in the study room.

Companionship is a component of virtual reality that can create great comfort for students. This focus on comfort, in the context of virtual reality and education, involves the use of technology that enables students to be more comfortable while their tasks are being accomplished. A more practical input for VR applications in education: the design criteria for comfort, stress and adaptation. Many studies have shown that comfort improves learning. Whether it's in the workplace or during class, comfort is a key ingredient for success. Virtual Reality erases the distance between the learner and information, allowing them an intuitive cognitive experience where they can ask questions, explore what they are learning in a hands-on way and learn while they learn.

A comfortable ride will make a person feel more confident and relaxed, which in turn helps them succeed in learning. With this in mind, a comfortable and engaging educational experience can be created for each individual child (Zhang et al., 2018). In order to achieve this goal, it is important for teachers to understand how humans perceive themselves within different environments and how these perceptions can be utilized to create a more supportive learning environment

CHAPTER 10

VIRTUAL REALITY AND AUGMENTED REALITY IN BUSINESS

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You might think of mind-bending video games when you hear the terms "augmented reality" or "virtual reality." However, these technologies have evolved into potent and profitable assets for businesses of all sizes. Some businesses have found success in increasing sales and distinguishing themselves from competitors by allowing customers to interact with their products and services in novel ways, even from the comfort of their own homes. Because of their use of precise 3D technology, augmented reality (AR) and virtual reality (VR) can be used in a variety of businesses as a tool for training and consulting. Explain the concepts of virtual and augmented reality. Virtual reality (VR) and augmented reality (AR) are vastly different. AR enhances the present by fusing digital content from computers (such as images, sounds, and text) with the physical world (Zeldin et al., 2008). In contrast, virtual reality completely replaces your current environment, whereas augmented reality only modifies it. A headset is typically required for the most immersive virtual reality experience.

To enjoy augmented reality, you'll need either a headset or, in some cases, just your smartphone. (Pokémon Go players can take their phones outside and use the built-in GPS and camera to track down virtual monsters to "catch and release." Augmented and virtual reality have numerous business applications. Customers can use their smartphones and augmented reality to imagine how an item will look in their own homes. "If they're buying a sofa, they'll know if it fits in the area," says Gary Radburn, director of virtual and augmented reality at Dell. "They'll be more at comfortable hitting 'purchase' because they've seen it in their context." Augmented reality (AR) has been shown to increase sales at brick-and-mortar stores by making the products more familiar and approachable to customers. Virtual reality has the potential to improve the shopper's experience. Customers in the market for a car, for example, can don a headset and see 360-degree images of different car models in a variety of colors and other options not accessible at the dealership before making a final decision. Virtual reality (VR) has the potential to revolutionize the design and construction industry by letting clients experience a building from any angle. Right now, AR and VR are indispensable business tools (Wu et al., 2019). Multiple business efforts benefit from the use of AR and VR technology. Further, a variety of training programs are available to show people how to use them effectively. This section explores the potential benefits of AR/VR for companies.

Figure 10.1: People with VR glasses playing virtual reality games.

Source: https://media.istockphoto.com/photos/people-with-vr-grasses-playing-virtual-reality-game-future-digital-picture-id1324380506?k=20&m=1324380506&s=612x612&w=0&h=fwRpT5vf5SU2Ak7SbeiDCYz-qNryra_0oUbBaJiaHhdo=

It would appear that the commercial applications of augmented reality (AR) are progressing toward more practical use cases. For example, Lacoste provides a smartphone app that lets customers see the shoes they want to buy while they're still in the store. The app shows the user what the shoes would look like on them in a bespoke size and provides information about the product. How is AR/VR affecting businesses generally? As well as providing potential in the gaming, narrative, and other entertainment industries, AR/VR creates significant economic benefits (Woolgar & Lezaun, 2013). The production of goods, the organization of meetings, and the transmission of information to and from customers are just some of the areas already impacted by technological advancements. The business sector is full of potential uses for augmented and virtual reality technology.

10.1 HOW VIRTUAL AND AUGMENTED REALITY HAVE ALREADY BENEFITED BUSINESS OWNERS

10.1.1 Retail

If you work in retail, you know how important it is to provide clients with a positive digital and purchase experience. The border between offline and online business is blurring and augmented and virtual reality can help your company capitalize. New media entertainment experiences and retail augmentation, such as virtual fitting rooms and viewing how furniture would look in a customer's house before purchase, could add as much as $204 billion to the retail sector's contribution to the nation's gross domestic product. Your clients won't buy from you unless you give them more ways to do so digitally (Wang, 2009). You'll also require digital showrooms to supplement your brick-and-mortar establishment. Virtual reality programmers may make a retailer stand out and give customers the best service possible.

10.1.2 Production Techniques

The availability of jobs in the manufacturing industry will shift when augmented and virtual reality are implemented. You will rely on remote help from other technicians or machines as part of your job as an industrial technician. Flaws and marks will be easily visible, making guesswork while manual effort is unnecessary. You may cut costs and improve quality by streamlining the manufacturing process. Human error is cut down, the efficiency of training is improved, and manufacturing times are shortened.

10.1.3 Recreational Activities

A company can make money by leveraging QR codes, advertising, or selling virtual reality games at retail locations. If you own an arcade, investing in virtual reality equipment and augmented reality/virtual reality games is a surefire way to boost business. In addition, escape rooms that use augmented or virtual reality technology are promising new areas of business. With today's technology, entrepreneurs don't have to construct a real-life escape room or model many rooms to simulate different settings like haunted houses or spacecraft (Antal & Grønli, 2003).

10.1.4 Construction and Property

The building and property development industries stand to benefit greatly from the use of augmented and virtual reality technologies. A virtual reality building will allow builders, electricians, and plumbers to inspect the structure for problems in design or drainage. Time, money, and effort spent on construction projects will all see improvements. If you manage a real estate company, you can provide potential tenants and buyers with a virtual tour of the properties you are leasing or selling. You might think of mind-bending video games when you hear the terms "augmented reality" or "virtual reality."

Figure 10.2: Metaverse and future digital technology man.

Source: https://media.istockphoto.com/photos/metaverse-and-future-digital-echnologyman-wearing-vr-glasses-hand-picture-id1357676694?k=20&m=1357676694&s=612x612&w=0&h=0RM01FsxdUah7AgoK_QXnwz2Fp3jH-F5YJZsE4XQmlgw=

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Figure 10.3: Print vector.

Source: https://media.istockphoto.com/vectors/print-vector-id1372924556?k=20&m=1372924556&s=612x612&w=0&h=o4u4I_2jTthoVb0JixcI-9FJtzyq-Z1l7j0OTqnvk-ps=

10.2 WHAT ARE VIRTUAL REALITY AND AUGMENTED REALITY

In contrast to Augmented Reality, which augments the actual world with computer-generated data, Virtual Reality offers synthetic or virtual experiences that are almost authentic and/or convincing. Viewing the environment in AR/VR now enables both exhilarating excursions and in-depth technical comprehension. Because of applications in industries as diverse as medical and entertainment, the augmented and virtual reality (AR/VR) business is predicted to be worth billions of dollars in the coming years. Future wearable screens will be sleeker, more aesthetically appealing, and deliver superior visual performance than predecessors (Woellert et al., 2011).

Figure 10.4: Architectural model home.

Source: https://media.istockphoto.com/photos/modern-architectural-model-home-as-vr-projection-picture-id1383131728?k=20&m=1383131728&s=612x612&w=0&h=t82-XQnvhR8vh0pJqrALwZag06cY7-8t57fwBzfmZEM=

The transition is caused via retinal projection, whose components are small enough to fit in current spectacles. This improves the contrast and resolution. Photonic Integrated Circuits (PICs) are ideal for usage in AR/VR display headsets due to their tiny size and excellent optical strength. PICs are the optimum answer for this application since optical components for accurate positioning and light quality control are simple to manufacture. LioniX International created the following tiny integrated devices for augmented and virtual reality applications: small, powerful, and flawlessly integrated.

During the manufacturing process of electronic devices, small, monolithically linked PICs are formed with the use of precise photolithography. PICs are instantaneously compatible with a broad range of other components, including control circuits, light interfaces, and RGB laser diodes. Energy-saving appliances Because of our low-loss photonic materials, even the most basic devices have a tight power limitation. Another advantage of PIC driver and control circuits over bulk optical components is their low power consumption. Silicon nitride photonic waveguides worked well over the whole visible spectrum in our studies. Integrated splitters and combiners allow for the precise color combination necessary to be transmitted (Whitcombe et al., 2014). Use pinpoint lighting to display the best resolution possible. Using the PIC's inbuilt gratings and mirrors, many light beams or patterns may be readily created and controlled. PICs' high precision manufacture also allows for incredibly exact placement, which would otherwise be unachievable with devices of this size. In some PIC applications, electrically adjustable components may be employed to guide light beams. Batch micro- and nanofabrication processes that are both simple to scale and have diminishing costs as production volume grows are used to produce scalable and competitively priced PICs. Payment via PIC is rare in high-throughput situations.

10.3 AUGMENTED REALITY IDEAS FOR BUSINESS

10.3.1 Trending Augmented Reality Business Opportunities

AR provides an enthralling and all-encompassing experience. It is now feasible to enhance the physical world in real-time with computer-generated sensory inputs such as video, music, and haptics. Because of fast expanding computer power and new depth-sensing technologies, this is now conceivable. Furthermore, a variety of advanced algorithms enable real-time object detection and enhancement (Verbeek et al., 2002). Researchers expect that 2.22 billion individuals will utilize this technology by 2023, up from 1.96 billion in 2021. The increase is probably due to the availability of more and better-augmented reality apps on the market.

Figure 10.5: Futuristic art gallery.

Source: https://media.istockphoto.com/photos/futuristic-art-gallery-with-vr-equipment-picture-id1356851842?k=20&m=1356851842&s=612x612&w=0&h=ed8axeOOyCZKKk5Uby1d0H8pJd5PuOUtRdI721E3qa4=

Even the greatest names in technology, such as Google, Apple, Facebook, and Samsung, are intrigued by augmented reality. Following the introduction of ARcore and ARkit for Android and iOS, companies have begun to spend heavily on augmented reality. Furthermore, the technique might be applied in other commercial domains such as building and medical. There are both offline and online retailers. The way we shop is always evolving as a result of AR. Retail is one of the most profitable industries for augmented reality to join. The practical applications of augmented reality in the corporate sector are fast developing. Mobile phone scanning may be used for a variety of purposes, including virtual dress fits and access to more information about an item. A journey around a grocery shop while noting the forms, sizes, and colors of the various goods is one possible application of augmented reality (AR). In comparison, the advantages of doing business online are considerably more obvious (Terrones, 2003). If you're on the fence about buying anything, you may use augmented reality to see how it might appear in your own home. Without leaving your house, augmented reality (AR) allows you to visually put on a variety of dresses, instantly change their colors, and gradually add accessories.

The most intriguing aspect of this is that it can be watched in real-time from a variety of angles and viewpoints. As a result, you may make a more educated purchasing decision. Because of how engaging and deep the experience is, augmented reality is an excellent learning tool. Teachers may give their students access to a rich and interesting virtual environment by using augmented reality (AR) technologies. Educational institutions throughout the world may use an AR curriculum to encourage more active learning among their student body. Consider reading a novel in which the characters come to life when you point your device at the page. As a result of these all-encompassing exercises, students' attention and understanding will both improve (Sismondo, 2018). With the help of these 3D representations, students may better relate to and comprehend the topic. By building cutting-edge educational augmented reality software, your organization may be able to meet the demands of a highly engaging instructional platform. This is especially important now that the pandemic has caused many students to switch to online classrooms. Exam Real History is one such example, which uses reality boards, cards, and a mobile application to offer students a new viewpoint. The card portrays historical figures, and when students see two cards via the app, they may witness the characters interact with one another.

The healthcare business is not the only one seeing dramatic changes as a result of the use of augmented reality; the education and retail industries are also having their economic potential redrawn. Augmented reality has various uses in healthcare, ranging from improving education for future physicians to allowing patients to self-diagnose. AR benefits students and medical professionals by improving learning, recall, and engagement by simplifying previously difficult subjects. Patients and medical personnel can both benefit from increased eyesight to better comprehend the following phases of a procedure. A 3D interactive experience is utilized as an extra benefit to demonstrate to patients and medical students how a drug works in the human body. The use of augmented reality (AR) to map a patient's anatomy makes it easier to identify veins before surgery and take blood for examination. A better understanding of tumors also allows clinicians to study and experiment with novel approaches to treat patients following surgery. This also allows medical workers to detect infections and map complicated organs, resulting in better patient diagnosis and treatment. Customers may be drawn to augmented reality due to the exciting new possibilities it offers. Providing an augmented reality experience to your customers may help you stand out from the crowd and create a memorable impression. Organizing one-of-a-kind events for your consumers is one approach to building their brand loyalty(Shannon et al., 2010). One option is to create business cards that, when viewed through AR, give important relationships and data. Make digital games for youngsters to enjoy while their parents browse the aisles of your business.

Figure 10.6: Metaverse technology background.

Source: https://media.istockphoto.com/vectors/metaverse-technology-background-vector-id1379108916?k=20&m=1379108916&s=612x612&w=0&h=_0_l0OXmHYdhMi0jWb5-eCRLR4BndFUyLYvs-jwt-CU=

10.4 TOURISM AND MAPS

The travel and mapping industries were among the first to see the advantages of an augmented reality application. The travel sector stands to benefit considerably from augmented reality's capacity to transfer people to another planet. Aside from the tourism business, augmented reality maps will influence every industry. For example, Google Maps today dominates the augmented reality (AR) mapping business. To help individuals navigate about, the firm provides on-screen instructions as well as real-time board and sign translations. The program's new on-screen interior navigation functionality is powered by a sophisticated network of technologies, including WiFi and Bluetooth. With the assistance of this navigation system, people may more easily navigate interior environments such as airports, retail malls, and metro stations (Suryanarayana et al., 2001). Any list of augmented reality company opportunities must include the industry that has rethought the potential of virtual reality and augmented reality.

Similar to how virtual reality changed the way we interact with video games, augmented reality will take this to a whole new level. This new development's revolutionary nature promotes creative ideas. Augmented reality game applications enable the greatest and most immersive gaming experience ever experienced. In terms of animation quality, computer-generated virtual items in real-world settings and places may eventually supplant traditional gaming. Unity 5 and ARPA are two cutting-edge technologies that might be utilized in conjunction with ARkit and ARcore to develop intriguing augmented reality video games. When sights, sounds, and pictures collide in real life, it creates an amazing experience.

10.5. STRUCTURES AND BUILDINGS

The advent of augmented reality software will usher in a new era of potential in the real estate industry. The days of displaying building projects via maps and drawings are long gone. AR will enable the display of dynamic 3D project models in real-world settings. Furthermore, as you go around the structure, the pieces and decorations change. You can also see through walls, windows, and doors from this vantage point. Because of enhanced software and technology, now is an excellent moment to investigate the commercial possibilities of augmented reality (Alexander et al., 2006). To mention a few, the construction and gaming sectors have already produced some of the most cutting-edge augmented reality capabilities.

Figure 10.7: A simulation picture.

Source: https://media.istockphoto.com/photos/architect-looking-at-a-simulation-picture-id1358849621?k=20&m=1358849621&s=612x612&w=0&h=WQESGs_a0XowsOhtu8jGIH4gFnWxNHQYoAjrDH5Vwag=

10.6 TELECONFERENCE APPS

Top Video Conferencing Apps

Zoom

Zoom brings teams together to get more done in a frictionless environment. Zoom's reliable, video-first unified communications platform provides video meetings, voice, webinars, and chat across desktops, phones, mobile devices, and conference systems (Swierstra & Rip, 2007).

Google Meet

Google Meet is a video conferencing app. using your browser, share your video, desktop, and presentations with teammates and customers.

ClickMeeting

Video conferencing software for product demos, training sessions, online courses, business meetings, and webinars.

Kaltura

Kaltura is the leading video platform powering any video experience for any organization.

Room

Stress-free video meeting and screen sharing, right within your browser and on mobile devices.

Polycom

Polycom provides open standards-based unified communications solutions for telepresence video and voice (Small, & Klavans, 2014).

GoTo Meeting

GoTo Meeting by LogMeIn is a world-class video conference software that makes it easier than ever to do business effectively even if you aren't in the same room.

Intermedia AnyMeeting

Hold online meetings and webinars to connect with sales prospects, clients, and new potential leads.

Daily. co

Daily. co lets you add video calls to any web page or app.

24sessions

24sessions help you to connect with customers via video chat effortlessly. They make this work by combining scheduling, video chat, and reviews all in a white-labeled platform (Rogers & Marres, 2000).

10.7 DATA VISUALIZATION

Data visualizations are visual representations of information and data. Data visualization tools use visual features like charts, graphs, and maps to aid in the discovery and assessment of patterns, anomalies, and trends in data. The more effectively you can use this data, whether through a dashboard or a presentation, the better off you will be. Citizen data scientists are gaining popularity. The data-driven economy is altering basic skill sets. Data-driven decision-makers who can envision how data influences who, what, when, and how are in great demand (Banerjee & Williams, 2013). While conventional schooling tends to draw a stark distinction between imaginative narrative and technical analysis, the modern industry favors individuals who can do both, and data visualization fills this need.

Data visualizations are visual representations of information and data. Data visualization tools use visual features like charts, graphs, and maps to aid in the discovery and assessment of patterns, anomalies, and trends in data. The age of Big Data has here, and it is critical that we fully comprehend its ramifications. With billions of rows of data being added every day, visualization is becoming increasingly vital in this "Big Data" era. Data visualization aids storytelling by making data more accessible by emphasizing patterns and outliers.

Figure 10.8: Virtual reality technology.

Source: https://media.istockphoto.com/photos/future-virtual-reality-technology-for-innovative-vr-warehouse-picture-id1334622728?k=20&m=1334622728&s=612x612&w=0&h=AQxFNqwhI-u1Sx9g6cfnj7kJU0rOy9g1ZejuLO-GL4Q0=

An effective data visualization should focus on the most important information while ignoring extraneous elements. It is more difficult to add the "info" element to an infographic or change the look of a graph. For successful data presentation, the right balance of form and function is required. Even the most visually appealing graphic can either succeed or fail horribly in expressing the desired idea. Even the simplest graph may fail to capture readers' attention, yet even if it succeeds, it may emphasize an essential topic. It takes expertise to blend intelligent analysis with appealing storytelling, as well as to ensure that the facts and images support one another. Why is it critical to employ data visualization in every field? It's difficult to conceive of a job that wouldn't benefit from greater data knowledge. There are several uses for those who can analyze and understand data, including but not limited to STEM areas, government, business, marketing, history, consumer products, services, sports, and others. Even though we will always wax poetic about data visualization, there are apparent practical applications (you are on the Tableau website, after all). Because of its vast use, the ability to imagine is one of the most sought-after qualities in a job prospect (Rao & Cheetham, 2001). The more effectively you can use this data, whether through a dashboard or a presentation, the better off you will be. Citizen data scientists are gaining popularity. The data-driven economy is altering basic skill sets. Data-driven decision-makers who can envision how data influences who, what, when, and how are in great demand. While conventional schooling tends to draw a stark distinction between imaginative narrative and technical analysis, the modern industry favors individuals who can do both, and data visualization fills this need.

10.8 MAPS AND TOURISM

The majority of available cartographic materials are tourist maps. The growing popularity of many types of tourism has resulted in a growth in the range of content, subject matter, and publishing titles catering to these markets. The authors believe that by creating this website, they will attract attention to a range of topics related to tourist maps, such as how these maps differ from one another in terms of modern tourism. Because of the dynamic nature of tourist maps, the authors opted to categorize them, which is logical given the numerous types of maps that have been discovered. The maps were classified according to their intended use: maps for sightseeing, maps for business or other sorts of tourism, maps of prominent tourist locations, and maps designed expressly for tourism marketing. The majority of cartographic archives are made up of tourist maps. Because of the increased interest, firms catering to visitors are extending their product options as well as the names of the magazines they publish. The creators of this website have several concerns concerning tourist maps, such as the fact that these maps may differ significantly in terms of current tourism.

Figure 10.9. Engineers working in an office.

Source: https://media.istockphoto.com/photos/diverse-team-of-engineers-working-in-office-at-industrial-factory-picture-id1353796860?k=20&m=1353796860&s=612x612&w=0&h=DYzSyKaFUlH1JVNEmvIy_aWoWQnS5-ncNeSbhI_7Cg0=

The authors choose to categorize tourist maps due to their dynamic character and because it is logical given the numerous sorts of maps we can now identify. Tourist city maps, advertising and promotional maps for the tourist sector, and other sorts of maps were also classified depending on their intended function and content.

10.9 APPLYING VR SERVICES FOR BUSINESS

Virtual reality may be used by sales teams to transfer consumers to interactive settings where they can test out items. Premise LED, a commercial and industrial LED producer, employs virtual reality to demonstrate to clients the difference in a room before and after lighting is installed. Companies may also employ virtual reality (VR) technology to display their products to clients. As a result, businesses may create apps to help with certain operations and to present their products in a more engaging light during trade shows. Zimmer Biomet is utilizing virtual reality (VR) to develop virtual dental laboratories where potential customers may test out their products and observe how they perform in real-world conditions (Porada et al., 2013). The options are nearly limitless here. To promote their items and increase sales, businesses might construct virtual catalogs, showrooms, and scenarios.

10.9.1 Manufacturing Design

In the same way that humans may make errors and learn from them in virtual reality, companies can use VR to experiment with various design methods. Virtual reality may be used to assist businesses in simplifying their operations while developing a new factory or changing the workflow of physical procedures. Before spending time and money on making scale models out of real-world materials, the team may develop virtual worlds and perform simulations to verify the viability of the new approach or concept. Those concerned may then be better equipped to predict what will and will not succeed. The use of virtual prototypes is predicted to expand due to the high expense of real prototypes and the widespread availability of 5G, which enables the VR experience. Taking in fresh air Virtual reality (VR) was expected to have a significant influence on the game business before its introduction. Virtual reality has profoundly revolutionized the gaming sector, but it is becoming evident that the corporate market is a far more profitable possibility for VR providers (Pahlavan & Makela, 2002). Although virtual reality has several business possibilities, just a few companies have committed to the technology thus far. In the future, more and more C-level executives will employ VR to gain a competitive advantage.

10.10 TO PROVIDE AN ENGAGING ENVIRONMENT FOR CORPORATE TRAINING

The young of today are easily sidetracked. It’s not difficult to attract their attention in the short term, but retaining it for any period is difficult. Unfortunately, in today’s hyper-connected society, it’s hard to concentrate without being interrupted by your phone. Pop-ups on Snapchat, Instagram Stories, and boring messages on WhatsApp all require instant responses and can easily induce obsessive checking. Workers in today’s organizations are typically on the losing end of economic transactions. To keep up with the rate of technological development, every effort is required. Because it is a matter of life and death, the team’s training and education must take precedence.

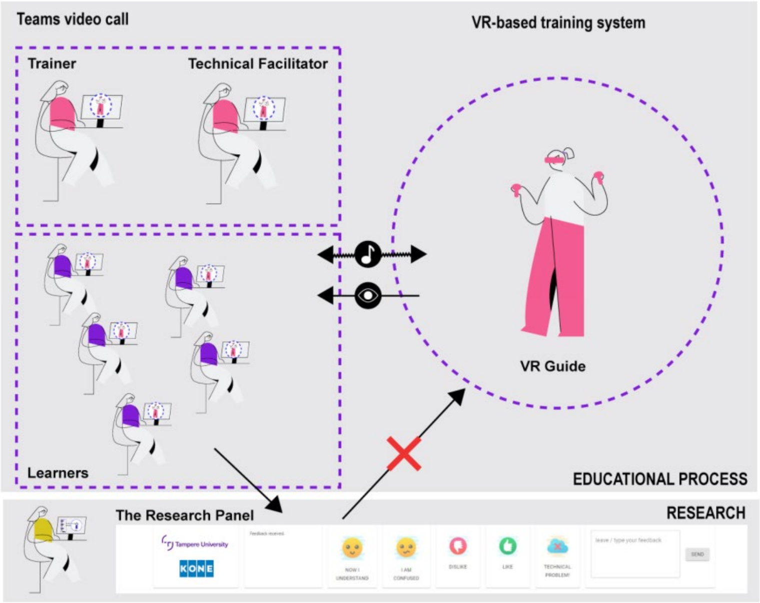

Figure 10.10: Virtual corporate training.

Source: Burova A, Opas V, Mäkelä J, Hakulinen J, Lindqvist T, Siltanen S, Raisamo R, Turunen M. Enhancing Remote Industrial Training Experiences with Asymmetric Virtual Reality: Experiences, Tools and Guidelines. Applied Sciences. 2022; 12(15):7745. https://doi.org/10.3390/app12157745

How do you react if this is the case?

Immersive learning has been shown to meet the requirements and has many applications in corporate training. In an immersive learning environment that is both fascinating and instructive, students actively participate in their education. To create each program, experts use cutting-edge technological tools to analyze and improve skills at every level. People who start a new career may have to relearn a lot of information they learned in school or on the job. Immersive learning is an on-the-job training alternative that consists of supervised experiential learning sessions rather than working while learning, which is time-consuming, reduces productivity, and can result in costly mistakes. Learners progress at their own pace, so their inexperience does not harm the company. Immersive learning increases students' interest and motivation in their studies significantly (Otsuka & Kakeshita, 2002). People are inspired to better themselves because of the tangible outcomes and instant gratification it provides. It can be tailored to a company's goals, procedures, and ethos, making it an excellent corporate learning option. The data also backs up my suspicions. According to studies, using virtual teaching laboratories instead of more traditional methods of instruction can increase student retention by up to 75%. While there is much enthusiasm for this new form of education, it has yet to become the preferred mode of instruction for all students worldwide due to several common misconceptions.

10.11 REVOLUTIONIZING E-COMMERCE

Many e-commerce issues have been addressed as a result of rapid technological advancement. Recent technological advancements have benefited both buyers and sellers. Customers may now acquire items and services from all over the world thanks to the rise of the internet marketplace. Even sellers may now be reimbursed remotely without lifting a muscle. E-commerce has advanced as a result of technological innovation. Because of advancements in website design, e-commerce businesses may now reach a larger audience. Rapid technological innovation has increased the speed and efficiency with which items and services may be acquired. Thanks to modern payment systems such as PayPal, Apple Pay, and Google Pay, consumers and sellers may now conduct business regardless of geographical distance (Nisbet et al., 2002). Buyers used to have to migrate from outside Africa to transfer money. This has made it easier for online companies to execute transactions. A lack of faith in the system has hampered e-commerce.

This problem has been solved by the introduction of blockchain technology, which protects the security of one's funds. The creation of these technologies has considerably benefitted e-commerce businesses. As a result, the gap between buyers and sellers has shrunk. Chatbots enable the direct online connection between customers and sellers. They are allowed to debate topics and even bargain for rates here. In addition, the dealer will provide the customer with a photograph of the item through email so that he may examine it. Because this transaction is online, neither the buyer nor the seller must travel. E-commerce transactions are now more efficient and less expensive for both customers and sellers as a result of this cutting-edge technology. Chart bots can incorporate information about previous sales and user reviews, depending on their level of sophistication (Badgujar et al., 2008). Customers gain confidence when they can see what other people have to say about a product they're thinking about buying.

Figure 10.11: Virtual reality game.

Source: https://media.istockphoto.com/photos/virtual-reality-gaming-and-metaverse-concept-women-have-fun-playing-picture-id1362951818?k=20&m=1362951818&s=612x612&w=0&h=Durez1es-dBjUoF8eJcxJviWSvi9N_vh-chD-WmJBbLg=

Products may now be delivered more rapidly thanks to technological improvements. Thanks to well-known companies such as Amazon.com, it is now possible to ship goods to the nearest warehouse. Thanks to technological advancements, it is now possible to order products, specify their location, and have them delivered straight to one's door. This has immensely benefited the e-commerce industry. Technology has made shipping things from foreign nations easier than ever before. The items you purchase are delivered by air to the nearest distribution location. From there, they'll be driven to your residence... It is plausible to claim that because technology has effectively shrunk the world to a little hamlet, e-commerce product distribution is now fairly simple.

10.12 EFFECTIVE PROTOTYPING

Effective prototyping is a vital tool for the design thinking process since it allows you to test your ideas in your intended market while simultaneously receiving feedback. Anything else requires the capacity to create and test quickly and efficiently.

- Always test prototypes with the appropriate audience for the greatest outcomes.
- It is critical to model success.
- Rapid prototyping is useful. The material should only offer the most crucial facts about the targeted product.
- Customers can assess how effectively their instructions were understood.
- Management can avoid expensive mistakes at the start of the development phase.
- Relationship improvements between designers and programmers

Figure 10.12: Ux developer.

Source: https://media.istockphoto.com/photos/close-up-ux-developer-and-ui-designer-use-augmented-reality-about-picture-id1300792680?k=20&m=1300792680&s=612x612&w=0&h=2ePwTK_CjCJGrCOouNAr5b0ZXEZ0LGWh-C8wa2ExIqac=

10.13 THE FIVE STEPS TO SUCCESSIVE PROTOTYPING

Prototypes have never been utilized to successfully launch a product. How can you ensure that your prototype will wow the audience if you want it to be a success? Consider the following methods to achieve a successful finish.

10.13.1 The Very First Step Is To Draw It

As a product developer, you understand how difficult it may be for you and your team to envision all of the functions your product would require at the outset of a project. The choosing of documentation is quick and easy. You don't have to be the next Leonardo da Vinci to share your thoughts. Simply draw a basic outline before adding more detail. Examine your product from every aspect available. How does the device's interior reflect the outside? You'll find that some design elements seem to function better than others as you sketch your product (Bøe et al., 2011). Because of the low cost and speed with which sketches may be produced, make as many adjustments as possible.

10.13.2 Begin As Soon As Possible And As Rudely As Possible

The three-dimensional construction of this entity will now begin. Rather than investing in early prototypes, seek low-cost materials that are easy to work with. You may also use chipboard, foam, clay, foam core, and muslin from your local charity store as an option. You'll also need a pair of scissors, a utility knife, and some sort of adhesive. When you create your first product, you will discover how it feels in your hands and appears to people in the real world. Do you believe your product has a market presence? If you discover a serious fault in your work, do not attempt to correct it. The appeal of low-cost materials influences the second component described here, repetition.

10.13.3. Remove

In other words, this isn't a one-time occurrence. Many companies' products go through several revisions to achieve the desired result. You will learn something new at first, and your job will improve as a result of this process. Don't throw anything away just yet. It's easy to get sidetracked while iterating, and attempting to add one feature at the expense of others can be risky. All you need to do to succeed in this *endeavor is keep previous prototypes for reference (Moore, 2013).*

10.13.4 Express Thanks for a Job Well Done

At any point during the iterative process, anything new can be done or created. To determine the success of your products, many product components must be evaluated. This process may include testing, ensuring that your grandmother can use it, and then launching the product. It may be difficult to distinguish between right and wrong; instead, evaluate the success of your strategy. Is it performing as it should? In the current situation, whether or not it works as expected Move on to the next challenge once you've confirmed that "Yes, it meets its goal."

10.13.5 The final prototype must be highly detailed

Ideally, the finished product should resemble this component. If you're doing everything yourself, use the techniques you've learned during your iterative process to make this prototype the best it can be. Even if you outsource the construction of your prototype or tech pack, the level of craftsmanship they encounter will reflect the level you require. Create your product in such a way that customers can see it in this light. If you are having goods manufactured, your prototype process may assist you in establishing specialized production lines (MacIá, 2005). Examine to see if the output from various fabricators and builders, equipment, or processes meets your specifications. If your Kickstarter campaign is successful, will they be able to obtain two million parts?

Product development is always a team effort, and the approaches described in this article are only a starting point. Put yourself under a lot of pressure to get your product to market as soon as possible. Instead, seek advice from your colleagues and manufacturers. Proper prototyping and research will result in a better-performing product in the marketplace than cheaply manufactured items mass-produced for profit. Consider whether or not the product is a success and what you can do about it.

10.14 EFFICIENT VIRTUAL BUSINESS MEETINGS

Because of the rise of the virtual, meetings may become increasingly difficult in the future. I have over 15 years of experience in conference and meeting management as a co-founder of a corporation and a human resources executive. Although I do not claim to have all the answers and have most certainly made countless mistakes along the way, as a result of my experiences, I have learned some best practices for conducting good meetings. These strategies and approaches may benefit everyone, from the CFO to the social media intern.

Determine if the meeting is genuinely necessary, and then be ruthless in choosing who must attend. Can't I just contact you over Slack, Skype, or email? When organizing meetings, keep in mind that "five minutes alone with six people is more valuable and productive than a thirty-minute chat with them all together."

If you check your calendar on a Monday morning, nothing but meetings, one-on-ones, and planned catch-ups will emerge. The beginning of the month, regardless of the date, is a good opportunity to organize recurring events and examine how you handle meetings and who needs to attend. Make certain that the meeting's purpose and leader are clearly stated ahead of time. Attendees will be better prepared for the meeting if they get a complete agenda or any required pre-reading material ahead of time. It is critical to keep the meeting on course and to refrain from wandering from the issue at hand (Martin, 2010). This may be accomplished in a variety of ways, such as encouraging participants to use "raise a hand" features or establishing defined periods for each person to talk during a remote conference. If there are any ongoing action items or pressing difficulties, ensure that everyone is aware of them and that they are documented in a shared document.

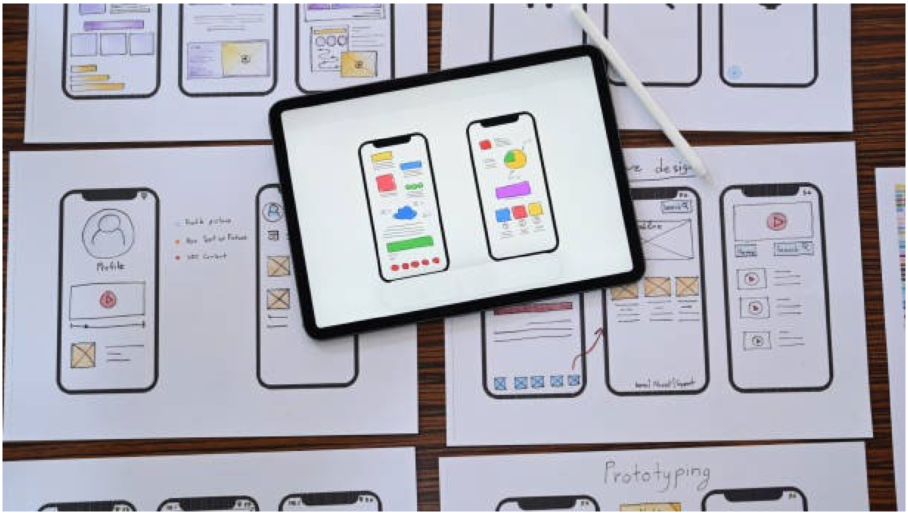

Figure 10.13: Web developer workplace.

Source: https://media.istockphoto.com/photos/web-developer-workplace-with-sketches-of-mobile-application-on-wooden-picture-id1390233671?k=20&m=1390233671&s=612x612&w=0&h=mdAw4c18rmgb2hPBDdw-0Ug-St2jkqWadSjR11cfjGdw=

Make a topic for discussion. Allow for some small talk before getting down to business. Avoid awkward, dull conversation starters like "Who are three celebrities you'd like to invite over for dinner?" Encourage individuals to bring their cameras as a starting point (at least initially). The addition of a new video conference background may spark some pre-work discussion.

In a remote or hybrid universe, play fairly. When we return to the office, no one will be able to work from home, therefore those who call in must be included and encouraged to participate. Allow as much room as possible for remote employees to interact and communicate vocally. Even if it's only a social call, take the initiative to make absent people feel present.

Organize high-energy, exciting meetings. Consider how you might make meetings more participative and engaging to keep them new and intriguing. For example, you may start with a quiz one week and finish with a Q&A the following. If you like, you can add a poll to the discussion. Sharing your own best practices is a fantastic idea. Participating in a five-minute discussion centered on a shared document may also assist to generate new ideas and boost morale (Liu & Zhang, 2011). We're all trying to get our bearings and make the most of our potential in this strange new environment. Keep your meetings fresh, humorous, engaging, and on-topic, and you'll see an increase in productivity.

10.15 ENHANCED RECRUITMENT PROCESS

Streamlining and automating recruitment and selection procedures may help businesses of all sizes.

The HR department is putting a lot of pressure on them. There is a lot of possibility for mistakes in the recruiting and selection process since there are so many moving parts. If you follow this advice, you will be able to enhance and master the entire procedure. Every stage of the employment process should be scrutinized. When feasible, use automation and research existing recruitment tactics from the standpoint of both the employer and the candidate.

10.16 MARKETING REDEFINED WITH VR

The subject of digital marketing, which today includes virtual reality, is dominated by technological advancements (VR). Marketers may utilize virtual reality to engage with their consumers more effectively as they strive for unique customer experiences.

Virtual reality (VR) offers an experience that resembles the real world by utilizing visual, auditory, and acoustic inputs, allowing users to interact with their environment. The great majority of virtual reality experiences are created using a specialized headset, allowing the user to become immersed in the virtual environment (Lieber, 2003).

The following are some examples of how virtual reality (VR) might be used in marketing to provide tailored and immersive customer experiences:

Customers who use experiential marketing are actively participating in the campaign and have a feeling of ownership over the company from which they purchase. Virtual reality (VR) simplifies the creation of a marketing campaign that immerses customers in a company's virtual world (VI). In addition to participating in the campaign, the client gets to use the promoted product.

Virtual reality has the potential to fill in the holes in traditional marketing and brand identification. Customers are more likely to remember the company, spread the word, and generate a lot of press since VR marketing initiatives immediately appeal to the target demographic and provide them with an interesting and memorable experience.

Make a name for yourself as a thought leader in your field. Despite the many benefits of virtual reality, some firms are hesitant to use it owing to concerns about its cost and use (Liu & Ihl Woo, 2006). Companies may use VR to establish themselves as thought leaders and innovators in their respective industries.

Figure 10.14: Augmented reality interior.

Source: https://media.istockphoto.com/photos/augmented-reality-interior-designing-house-planning-app-picture-id1329382476?k=20&m=1329382476&s=612x612&w=0&h=IVRgdb3CGObqeTGdclSDHYYVPeCtzJ8ArYHArAFk-wm4=

Display advertising is an expensive approach to getting traction. In contrast, virtual marketing campaigns are substantial in their own right. VR was significantly used in the debut of Volvo, an American automobile manufacturer. The XC90 is Volvo's most recent SUV. Anyone can drive a new Volvo using Google Cardboard and "Volvo Reality." Potential buyers might now do virtual test drives as a result of this. As a result, there were 238 million PR impressions, 19 million social media impressions, 24 earned news items, and 500,000 site page hits, as well as a variety of other advantages (Bernardes & e Albuquerque, 2003).

Virtual reality has enormous promise, even if it has not yet garnered the same widespread acceptance as augmented reality. Businesses have a moral duty to assist their workers in the development of innovative ideas.

CHAPTER 11

DIGITAL INNOVATIONS IN AVIATION SECURITY

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The employment of technology in the aviation industry "promotes great efficiencies and capacity, enhancing our sector's capabilities as a catalyst for socioeconomic and environmental advantages." Given that international connectivity and ICAO-compliant aviation services are already assisting the world in meeting 15 of the 17 SDGs, this is crucial. Improvements in digital, augmented reality, and artificial intelligence (AI) technologies have enabled more accuracy and less downtime than ever before in pre-screening individuals and things for potential hazards to health and safety (Kobayashi et al., 2019).

Figure 11.1: Managing engineer.

Source:https://media.istockphoto.com/photos/managing-engineer-and-chief-technician-working-on-satellite-talk-use-picture-id1323369757?k=20&m=1323369757&s=612x612&w=0&h=pQhvE7RPq-jZnznFeL3a1YzbINURFhx-soOp7ZsKD5r4=

They also provide the framework for self-driving cars, unmanned aircraft systems, and other future technologies that will benefit transportation, business, government, and the public good. "You can depend on us to be your devoted and successful partner in all innovation-related matters coming ahead," Dr. Liu promised the audience. "We aspire to acquire greater flexibility, responsiveness, and efficacy in the study and rulemaking of evolving technologies," he says plainly. The International Telecommunication Union (ITU) is an important partner for the International

Civil Aviation Organization (ICAO) in our efforts to create a sustainable and creative digital future for future generations.

11.1 PASSENGER SCREENING

Worldwide events serve as regular reminders of the need for airport and aviation security. Some goods are prohibited from being transported onto an airline in Australia to guarantee the safety of all passengers. To reduce the danger of a security breach, all people and their luggage should be scrutinized. Though inconvenient, security processes are critical to our safety (Howe-Walsh & Turnbull, 2016). You will have no issue going through security checks if you are familiar with airport protocol. Here, the example of Australia is described.

Figure 11.2: People waiting for Covid test.

Source:https://media.istockphoto.com/photos/people-waiting-for-covid19-test-outside-of-adelaide-airport-picture-id1360755332?k=20&m=1360755332&s=612x612&w=0&h=8p1wCDkNAbH6bRalMEXZkj_VNnuk6nY_mLNmP-PInufc=

Airport Confidence

Aviation security in Australia and other nations may be more or lower depending on the airport. Before you go, check with your airline or the nation you'll be visiting to confirm any regulations.

Scanning of the Body

Security scanners in Australian airports examine passengers from head to toe for prohibited items. Every time a body scanner is used, you may be chosen at random. You will not be permitted to board your aircraft or proceed through security if you refuse to submit to a search.

Health and Security

All body scanners in Australia employ millimeter-wave technology, which emits no ionizing radiation. As a result, x-rays do not emit ionizing radiation, as demonstrated above. Because the waves are faint and the process is quick, you receive significantly less energy from the scan than typical things such as cell phones. Millimeter waves cannot penetrate the body because they are reflected by the skin. Scans have no known health hazards, therefore pregnant women and individuals with prior medical conditions should feel comfortable having one (Breschi & Catalini, 2010).

Privacy

In Australia, extra precautions are in place to protect your privacy while utilizing body scanners. The photographs are then overlaid with a basic stick figure to identify the locations that require additional investigation. Passengers' personally identifiable information cannot be saved by scanners.

Before deploying this technology, government agencies spoke with organizations such as the Australian Information Commissioner's Office, Vision Australia, the Gender Centre, and Organization Intersex International.

Precise specifications

The government realizes that you may be concerned about the impact of deploying body scanners in your particular situation.

11.2 RISK ASSESSMENT PROCEDURE

Before accessing the protected part of an Australian airport terminal and boarding an aircraft, all passengers must pass through security checks. This category includes all airport visits, including passengers, gate visitors, crew members, and airport personnel (Hagendijk & Irwin, 2006).

- Before you go to the airport, make sure you understand what you can and cannot bring on board, as well as the screening procedure.
- Bring everything you need in your carry-on, including your wallet and pocketbook.
- Insert the tray with your gel, liquid, and aerosol products into the slot (departing international terminal only).
- Place powder canisters in separate trays (departing international terminal only).
- Place on the tray everything metallic (keys, cash) or electrical (laptops, smartphones).
- The tray may hold heavy items such as coats and jackets, as well as hats and jewelry (Granato et al., 2014).
- You should see your luggage on the conveyor belt.
- Please notify the screening personnel if you have any implants, aids, or medical equipment before checking in.
- Pass past the metal detector in the corridor. If you travel internationally, you may be required to submit a random body scan (Grupp & Mogee, 2004).

A random selection of persons who pass the initial screening is subjected to explosive trace detection testing. When you enter a screening area, you consent to any screening processes. If a pat-down search is judged essential, you will be asked for your permission.

Figure 11.3: Contactless payments.

Source:https://media.istockphoto.com/photos/contactless-payment-in-a-coffee-shop-picture-id1386502250?k=20&m=1386502250&s=612x612&w=0&h=7InsahrkarCwJjbiqnvRfkUndJ4_Cg1XGkISodomrUI=

You have the right to decline any screening that is being provided. If you answer no, you will not be allowed to board the airline or pass through security.

11.2.1 MillimetreWave Advanced Imaging Technology

Because of its ability to acquire high spatial resolution (mm-level) and penetrate certain package materials with non-ionizing radiation, millimeter-wave technology has recently gained popularity for use in security screening and imaging (Bengisu & Nekhili, 2006). The National Institute of Standards and Technology (NIST) Security Technologies Group (STG) investigates both dynamic and static structures (STG).

Figure 11.4: Aerospace engineers.

Source:https://media.istockphoto.com/photos/meeting-of-aerospace-engineers-working-on-unmanned-aerial-vehicle-picture-id1270623485?k=20&m=1270623485&s=612x612&w=0&h=YMj84RLzX9KWLZh7QdCaDvFx-P2n0ylsdiLeoPr-3U4k=

The STG and the NIST Quantum Electromagnetics Division collaborated to develop a cutting-edge passive millimeter-wave imaging system based on cryoelectronic sensor arrays. This system will set the framework for the creation of internationally accepted standards, test objects, and test and evaluation methodologies for NIST's millimeter-wave imager metrology.

The camera can capture both static and moving images at a range of 10-20 meters. The telescope features an f/2.0 Cassegrain aperture and a 1.3-meter-diameter main mirror. The 10% bandwidth is centered at 350 GHz and is computed by directing light into a cryostat and passing it through a series of filters (Bell & Lederman, 2003). The focus plane is chilled to 950 mK to employ superconducting TES bolometers.

11.3 COCKPIT WEATHER INFORMATION SYSTEM

Weather-dependent industries benefit from increased output and security. The Weather Cockpit® data (is discussed here as an example) to better allocate and prepare their available resources during bad weather. This improves processes while ensuring worker safety.

Because of the weather, businesses have unique hurdles in managing their operating operations and allocating their resources.

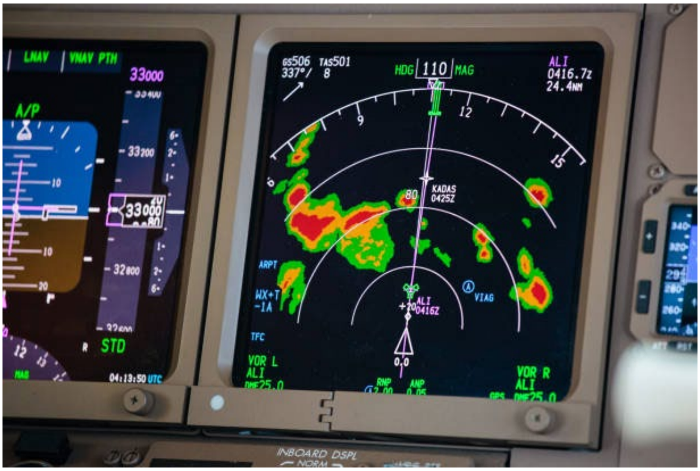

Figure 11.5: Weather radar in cockpit.

Source:https://media.istockphoto.com/photos/weather-radar-in-the-cockpit-showing-thunderstorms-picture-id1200477079?k=20&m=1200477079&s=612x612&w=0&h=j8oLUvIpgdAFOmu7g5gwMSgZDleb5od5lO_2DBXiu6I=

Do you wish to increase production at several facilities around the clock?

Is it truly necessary for you to be protected against lightning strikes?

Do you believe winter service coordination must be completed in a timely and cost-effective manner?

Do you handle the infrastructure that requires special attention under extreme weather conditions such as ice, sand/snow drifts, storms, freezing rain, and so on? Examples of such infrastructures include the distribution of electricity, the construction of rail lines, and the construction of roadways (Gandini, 2011).

In this situation, the intuitive UBIMET Weather Cockpit® is the cutting-edge technology that can reflect unique organizational processes such as resource planning and alerts while also giving best practices for a wide variety of business sectors.

11.3.1 Weather Cockpit® Professional Software

The Weather Cockpit® is an easy-to-use website that gives accurate weather reports, predictions and alerts based on the user's specific location. This professional program is easy to use and customized to your specific needs. The application provides easy access to meteorological data and properly depicts weather events on highly detailed maps for routes, places, and regions (Ferrari et al., 2015).

Figure 11.6: Cockpit picture.

Source:https://media.istockphoto.com/photos/st-elmos-fire-seen-from-a-cockpit-picture-id1353826536?k=20&m=1353826536&s=612x612&w=0&h=-om4MrRhbGwZzBIvhibDRraspRLR5HjCVGcHAcadWtI=

How strong is the wind right now? Is it possible to utilize a crane? Is there a risk that a golf tournament may be canceled due to inclement weather? Will I have to send out my winter service personnel if the snowfall tonight is significant? In addition to real meteorological data such as precipitation radar or lightning detection, hourly predictions for temperature, rain, wind, and other parameters are offered for the chosen location(s) and area (s). The traffic-light system can help you determine the optimal time to complete important tasks and establish personal limitations for weather-dependent activities (Ferguson & Zhang, 2002). Text messages extreme weather warnings and other notifications give employees up-to-the-minute information on what they can do to be safe. The Weather Cockpit® is a specialized weather application that organizations may utilize to improve safety and output.

Here are some of the advantages of utilizing the Weather Cockpit

- Weather forecasts and updates on current conditions
- The danger of bodily harm and property damage is lowered.
- Reduced costs as a result of more effective use of resources and manpower
    - A smart weather app that is simple to use and has a large variety of customization options.
    - Email, text message, and push notification notifications for notifications and alerts

Figure 11.7: Pilots hands accelerating throttle.

Source:https://media.istockphoto.com/photos/pilots-hand-accelerating-on-the-throttle-in-a-commercial-airliner-picture-id1070016456?k=20&m=1070016456&s=612x612&w=0&h=1uE990cPpH75PUPWdrKxs090C6Owm0xlT_jd-NYS66qU=

11.4 NEW TECHNOLOGIES FOR REDUCING AVIATION WEATHER-RELATED ACCIDENTS

One of the new technologies that have evolved in recent years is the data linking of weather information between airplanes in flight and suppliers and consumers on the ground. Others include graphical weather data presentation in the cockpit, turbulence prediction and warning, and automatic airborne in-situ weather reporting. NASA collaborated with the Federal Aviation Administration (FAA), the National Oceanic and Atmospheric Administration (NOAA), the scientific community, and the private sector to create technology. Weather-Related Aircraft Cockpit Displays If bad weather requires a change in flight plans, the pilot must be able to determine where the weather is better and how to get there quickly. An aviation weather information (AWIN) system consists of weather products, a distribution strategy, and a method of data presentation. Pilots consider a range of elements other than weather when establishing flight plans. Terrain, impediments, traffic, and airspace rules, as well as the plane's and pilot's skills, are all factors to consider (Borup et al., 2006). It is critical to have a method for data to be sent from the plane to ground control. Aircraft-to-aircraft communications may be critical for the timely delivery of in-flight weather reports. Weather systems on the ground can be updated with data from onboard sensors, which can then be sent to aircraft in flight. The usage of data-link weather information systems can improve the effectiveness of onboard sensors such as weather radar and lightning detectors.

Figure 11.8: Army aero scope engineers.

Source:https://media.istockphoto.com/photos/army-aerospace-engineers-work-on-unmanned-aerial-vehicle-drone-picture-id1270623266?k=20&m=1270623266&s=612x612&w=0&h=-VAi01PZP7Q5mH3aEJacL4LCGotLrN-vdN_Y9kVHaoeU=

NASA has worked to improve global and national capacity for transport aviation, safety, weather, turbulence, data link, and cockpit systems, as well as general aviation (GA) aircraft data-link weather information capabilities. These various end-users requirements for fixed and mobile weather display solutions have been evaluated. All weather information presented in the cockpit must be up to date, accurate, and displayed in a way that assists pilots in making decisions that result in safe and effective actions. Primitive techniques (2.1) NASA initiated cooperative research activities with industry-led teams in 1998 to "kick-start" the development and deployment of AWIN systems. Teams headed by Boeing and Honeywell for international transportation and ARNAV Systems and Honeywell-Bendix/King for domestic general aviation in the United States demonstrated prototypes and in-service testing of these entire systems. In these "first generation" systems, existing weather products were updated for data transmission and cockpit display (Floros et al., 2010).

This technology was used to build the Flight Information Services Data Link (FISDL) system, which offers data-link weather for the whole United States. The FISDL system became active in 2002. Honeywell International cooperated with NASA to create a Weather Information Network to bring graphic weather data to the cockpits of commercial and business aircraft traveling around the world (WINN). The network is made up of aerial displays, airborne and ground-based computers, a variety of meteorological commodities, and data-link service providers. Because of the open design, any data-link technology may be supported. A satellite link, as well as a VHF/UHF telephone connection on Earth, were studied. Various types of weather data can be overlaid or seen individually. During the winter of 2001, United Airlines conducted around 40 ISE flights using a prototype electronic flight bag outfitted with the WINN system. The aircraft received airport observations (METARs), terminal area forecasts (TAFs), ground weather radar reflectivity (NEXRAD), turbulence, and critical weather warnings (graphic SIGMETs), and satellite cloud images through a GTE Air phone. We were able to reduce travel times by 1-2 percent on each trip by keeping an eye on the weather prediction.

The volume of communications delivered via the Aircraft Communications Addressing and Reporting System (ACARS) was expected to drop by 40-50 percent. (And, as a result, expense). There are already commercially available data-link cockpit weather information systems in the United States, which are especially beneficial for general aviation (Foest et al., 2006). To fulfill the diverse demands of GA operators, multiple types of displays and data transmission technologies are employed. The FAA has begun constructing a UAT (Universal Access Transceiver) network across the United States to data-link the cockpits of equipped aircraft to traffic and flight operational information, including weather.

11.5 WEATHER EYE

When it comes to HVAC, "The Weather Eye" has been dubbed "the first extraordinary quality heating and ventilation system." That same year, cars in the 3900 series received defoggers (defrosters). Nils Eric Wahlberg's air-conditioning and heating system for Nash is still in use today.

Nash was a pioneer in automated temperature management for a heating system's airside, with the thermostat monitoring three air temperatures to keep passengers comfortable: the incoming outside air, the heater's discharge, and the inside of the vehicle (Dhillon et al., 2017).

Nash's Conditioned Air System was supposed to include a heater dubbed "Weather Eye." Because it was said to monitor the weather, the thermostat was given the nickname "mechanical eye."

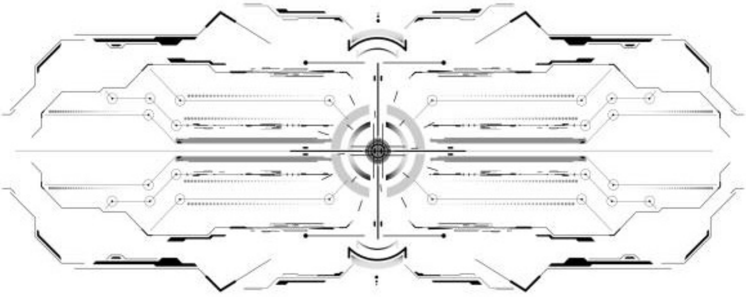

Figure 11.9: Modern aiming system.

Source:https://media.istockphoto.com/vectors/modern-aiming-system-device-tilt-level-aim-military-aim-system-vector-id1393983731?k=20&m=1393983731&s=612x612&w=0&h=KtNShqdWLLPXkJQxVSNkYbzgtmOkkFXUq_UeaXId1Ho=

Every Single Climate Observation: The switches for the vent, fridge, heat, and defrost are all conveniently located on the dashboard. In 1954, Nash-Kelvinator used its refrigeration expertise to create the first compact and reasonably priced single-unit heating and air conditioning system for the Nash Ambassador, Statesman, and Rambler. In a hidden location, an actual vapor-compression refrigeration system was installed.

Nash dubbed his innovative HVAC system, which combined heating, cooling, and ventilation, the “All-Weather Eye.”

In 1954, Nash vehicles were the first in the United States to feature front-engine HVAC. To the best of my knowledge, this was the first mass-produced item with an electric clutch and controls located on the dashboard (Chadwick et al., 2011).

All of the parts for this compact and easy-to-maintain “first real refrigerated air conditioning system” for vehicles were stored under the hood or in the cowl area. The Nash passenger compartment air conditioning option, which can be controlled by a single thermostat, was praised as “great and surprisingly reasonable.” A heating and cooling system that was fully integrated into the engine compartment blew cold air into the cabin through dashboard vents.

Nash’s “great invention” was not only a “sophisticated” unified system, but it also cost much less than competing systems — just $345. An Oldsmobile’s optional air conditioning system cost an extra $199 and weighed twice as much as the integrated Nash unit (an additional 133 pounds) (60 kg).

The air conditioning thermostat control included a “desert only” setting that kept the compressor running continuously. If the compressor runs continuously in humid conditions, the evaporator will freeze due to moisture accumulation, impeding airflow (Doi, 2006). By cycling the compressor, other temperature settings can prevent this issue. Freezing is not a concern in arid regions such as deserts, and this option provides continuous cool airflow to the passenger compartment.

11.5.1 Contaminated Runway Detection Technology

The weather has a significant impact on the aviation sector. During the winter, Japan may have some of the world’s most challenging flying conditions. Due to their inclination to adhere to the aircraft, snow, and ice, for example, can considerably impair an airplane’s performance, particularly during takeoff. Runway overruns are more common in Japan when it snows, due to the combination of the slippery quality of the snow and the fact that relatively large aircraft fly on relatively small runways (Cao et al., 2006). The devastating potential of a lightning strike during the winter is significantly larger than in the summer.

Figure 11.10: Back of an airplane.

Source:https://media.istockphoto.com/photos/the-back-of-an-airplane-to-take-off-picture-id696113732?k=20&m=696113732&s=612x612&w=0&h=Q4maFQ9tIiJ51WxF0xtXUYqyvXEuqEAIvZ7VOiAsr4w=

Planes are built to maintain a certain level of safety even when faced with hazardous conditions such as ice and snow adhesion, lightning, and other dangers. It's also true that individuals spend time and effort to ensure their safe operation, even if it means sacrificing some productivity. If the weather turns out to be substantially worse than predicted, really disastrous effects are conceivable.

The WEATHER-Endurance Aircraft Technology to Hold, Evade, and Recover by Eye (WEATHER-Endurance Aircraft Technology to Hold, Evade, and Recover by Eye) suite of devices detects airframe, runway, and weather conditions and predicts and protects against weather impact (Zhang et al., 2018). WEATHER-Eye technologies include those used to identify filthy runways, assess the lightning threat, shield aircraft from lightning strikes, avoid engine freezing and de-icing, and protect aircraft from CMAS formation (calcium-magnesium-aluminum-silicate).

11.5.2 Lightning Risk Prediction Technology

We tackle lightning warnings in a completely different way than any other firm in the industry. Most other sectors assess the danger presented by lightning using detection and/or time of arrival (TOA) methodologies.

Because electromagnetic (EMF) disturbances in the environment lie at the heart of detecting technology, we might think of them as "static" on an AM radio. Even with cutting-edge technology, all that can be gleaned is how distant you were from a prior lightning strike. Due to the multiple sources of EMF in our daily lives, filters are often necessary for detecting equipment to filter out lower amperage lightning strikes. Missed strikes and delayed notification occur because detection systems must wait for an event to occur before issuing a warning (Zeldin et al., 2008). Finally, it can take up to 30 minutes after a strike is detected inside the warning zone (often a 10-mile radius) for detection systems to signal the all-clear, which is a huge waste of time for both small athletic arenas and massive mining operations.

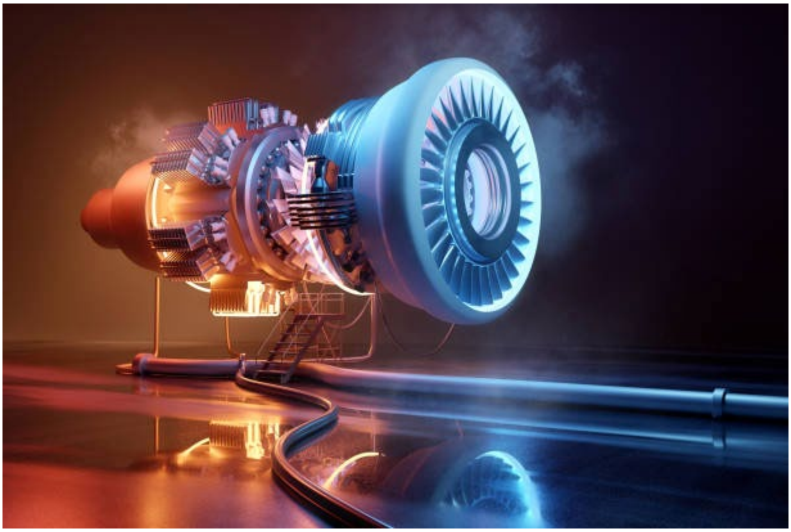

Figure 11.11: Jet engine.

Source:https://media.istockphoto.com/photos/futuristic-jet-engine-engineering-concept-picture-id1193095380?k=20&m=1193095380&s=612x612&w=0&h=2zT3gKoGaqBHVY7R7Iosp_JnyPfMs__Ci1Qa12oDDJo=

Our solutions are designed to continuously monitor the intensity of the electromagnetic field and utilize that information to forecast where lightning will strike in the local vicinity (typically within a 2-2.5 mile radius). Thor Guard devices eliminate all lightning-related worry from any outdoor activity, whether it's a park baseball game, a round of golf, or a day of backyard construction. As a result, it's necessary to understand not just when to stop an outside activity and seek cover, but also, and maybe more importantly, whether to continue it (Wu et al., 2019).

11.5.3 Lightning Protection Technology

The primary purpose of lightning protection systems is to prevent or minimize property damage caused by lightning. They are critical in lowering the danger of fire and electrocution by protecting a building's electrical systems. A lightning conductor—typically a metal rod—is erected to protect a building against lightning strikes. A lightning strike will first strike the lightning rod, which will then transmit the strike down the cable and out of the structure.

It is difficult to design a system that can prevent all lightning strikes since lightning can strike at any moment and with any intensity. Even if a lightning protection system splits the current and sends separate pathways to the ground, some harm is still possible (Woolgar & Lezaun, 2013). These additional "side-flashes" have the potential to start a fire, fracture masonry, stone, or concrete, or hurt individuals within the building.

It is your job as a company owner to follow local, state, and federal regulations concerning lightning protection. According to risk control publication RC 35, "Protection of buildings against lightning strikes," it is not essential by law that all buildings and structures have lightning protection. Most enterprises, on the other hand, are covered by the Electricity at Work Regulations of 1989.

A detailed risk assessment is required to understand your building's sensitivity to lightning strikes and your legal duties. Several types of structures are more likely to be struck by lightning. When determining the potential hazard posed by a structure, its size, and height, as well as the number of yearly lightning strikes per square mile, will be considered. As a result, a smaller building is less likely to be struck by lightning than a bigger one, and a structure in a high lightning strike density region is more likely to be struck than one in a low lightning strike density one. BS EN/IEC 62305 requires a risk assessment every year to ensure your lightning protection system is up to code (Wang, 2009).

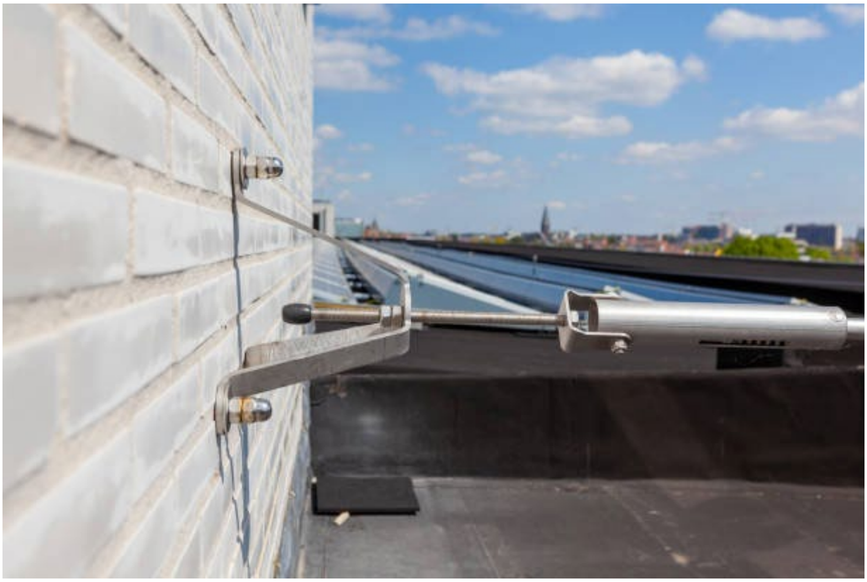

Figure 11.12: Safety cable.

Source:https://media.istockphoto.com/photos/safety-cable-on-the-roof-picture-id1394886026?k=20&m=1394886026&s=612x612&w=0&h=kx-OSruU8n_Lpbqo_xRy6h6nmzXkaIqSDpon9SNGQgs=

Installing a lightning protection system entails more than simply following the laws and regulations. Preventing lightning strikes is a crucial aspect of building safety. Lightning strikes may wreak havoc on businesses, necessitating downtime, costly repairs, and a decrease in productivity. When preventative measures are implemented, your company's bottom line and output will improve.

CHAPTER 12

SMART FARMING AND PRECISION AGRICULTURE

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INTRODUCTION

Precision or "smart farming" refers to the use of agricultural inputs in a precise way determined by soil conditions, weather conditions, and crop requirements when it comes to increasing crop output and quality. Pierce and Nowak both (1999). Some of the factors that influence precision agriculture implementation are the degree to which field conditions can be monitored and controlled, the adequacy of input recommendations, and the amount of application control. A wide range of cutting-edge technology, including computers, GPS, geographic information systems (GIS), remote sensing (RS), and application control, enable precision agriculture (Wynne, 2007). Precision agriculture takes a wide range of variables into account, including soil resources, weather, plant genetics, crop variety, machinery performance, and the overwhelming majority of physical, chemical, and biological inputs used in agricultural production.

Figure 12.1: Smart Farming and Precision Agriculture.

Source: https://media.istockphoto.com/photos/smart-farming-with-iot-futuristic-agriculture-concept-picture-id1255871842?k=20&m=1255871842&s=612x612&w=0&h=Wp01YHJ2elxAxwbRboKPBR95nrGJP5ISQDYXkLO9FtU=

Precision agriculture must be lucrative, but it must also respect the needs and resources of individual farmers. The following is an outline of the essential components of precision agriculture: determining the variability the first step in precision farming is to assess the degree of variability. To put it another way, if you don't know what you're doing, you can't govern over anything. Crop yields vary throughout time and region as a result of a range of variables. One of the most challenging challenges in precision agriculture is determining what, if any, processes or components are vulnerable to variation, as well as when and where that variation occurs. Surveying, interpolating point samples, high-resolution sensing, and modeling approaches are required to get this variability.

12.1 REGULATING VARIABILITY

Farmers must follow management recommendations derived from proper variation analysis to match their agronomic inputs to the conditions of their fields. To tailor them to the individual spot, a precise application control approach is employed. Management occurs in several phases. Precision agriculture includes pest control, crop management, water management, soil management, and exact soil fertility management. When analyzing the economics of precision agriculture, it is critical to remember that value is created via the utilization of data rather than technology. Environmental advantages are commonly cited as justifications for precision farming. Pesticide use decreases, fertilizer use increases, controlled inputs become more efficient, and soil output improves as a result of soil deterioration. Precision agriculture may become a feasible alternative with the correct agronomic principles and decision-making criteria (Ali, 2015). Crop characteristics, soil characteristics (topography, fertility status, texture, moisture content/retention, tillage needs, and other characteristics), pest incidence (insects, diseases, weeds, and other characteristics), weather/climatic conditions, other biotic and abiotic stresses, plant growth response, harvest and post-harvest handling, marketing, and market intelligence are all examples of precision farming information (Antal & Grønli, 2003). Soil qualities, groundwater, insect incidence, and herbicide dispersion may all be used to build maps of farms, cities, and regions.

These maps can help farmers make better farming decisions by allowing them to use data that is easily available at each stage of the process. These maps may be used by planners to regulate the flow of inputs in some areas. Farmers must keep current on technology improvements to increase productivity and profit margins. Geographic information systems (GIS), auto-analyzers, sensors, computers, and appropriate software may all help with the correct diagnosis of nutritional deficiencies as well as other biotic and abiotic stressors at the farm, village, and regional levels. Soil, water, fertilizer, pests, and crops may all be included when calculating the monetary worth of the different limitations. They can give significant assistance in the implementation of integrated management systems by regulating soil health, pests, nutrients, water, and energy, as well as varied crop genetic resources. Sensors can be employed after harvesting to monitor and enhance product quality. It is critical to employ all available technologies efficiently.

A comprehensive management system will be constructed by merging the gathered data with the already available technologies. Accurate agricultural outputs will be difficult to get if management efficiency is low. Farmers must be able to understand the data presented, apply the available tools, and make sound production decisions. Precision Agriculture Technology and Tools "GPS" is an abbreviation for "Global Positioning System." The acronym for satellite-based navigation is "GPS," which stands for "Global Positioning System" (GPS). In the 1970s, a department of the United States Department of Defense designed and deployed the Global Positioning System (GPS). The Global Positioning System (GPS) was designed largely for military purposes to give precise position and timing information (GPS). GPS is now utilized in commerce, agriculture, robots, and time synchronization. A satellite navigation system, the Global Positioning System (GPS), allows users to record positional data (latitude, longitude, and elevation) with an accuracy of 100 to 0.01 meters (Woellert et al., 2011). GPS satellite transmissions enable GPS receivers to identify their precise position. Farmers can utilize the method to target certain fields based on their historical input applications and performance. Each field may receive individually adjusted inputs.

12.2 VARIABLE RATE CONTROLLERS

To regulate sprayers and fertilizer spreaders, real-time sensing devices or pre-made prescription maps can be used. The machine or the operator can control these systems. The primary goal is to alter application rates based on the amount of product that is most appropriate for each situation.

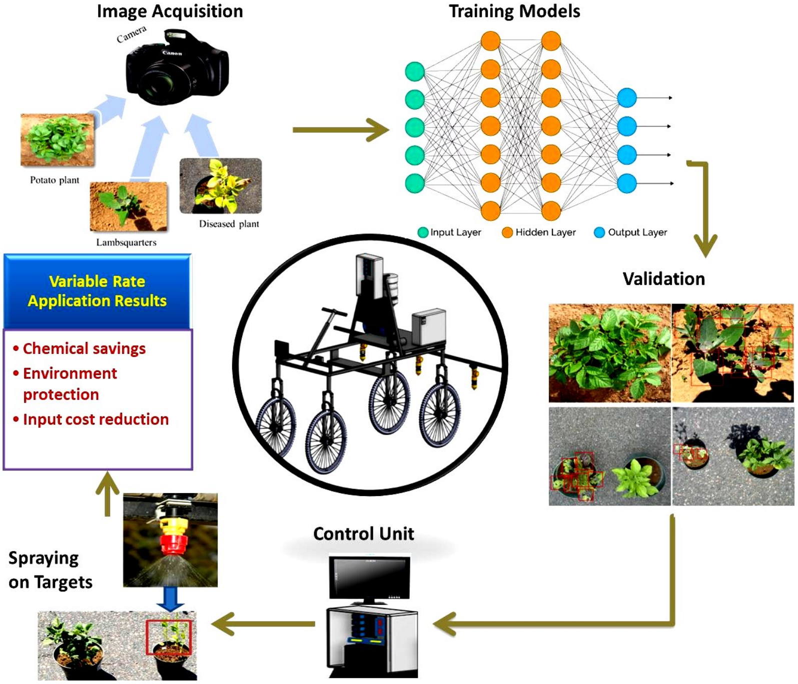

Figure 12.2: Variable Rate Controllers.

Source: Hussain N, Farooque AA, Schumann AW, McKenzie-Gopsill A, Esau T, Abbas F, Acharya B, Zaman Q. Design and Development of a Smart Variable Rate Sprayer Using Deep Learning. Remote Sensing. 2020; 12(24):4091. https://doi.org/10.3390/rs12244091

This might involve determining fertilizer rates based on soil testing results or selecting agrochemical inputs based on the crop's characteristics.

As a result of the unique demands on the hardware and other considerations, each application necessitates a unique approach to issue resolution. A GNSS receiver and a rate controller with VR capabilities are required in all cases. As a rule of thumb, most N-Sensor systems have their controller, which provides the rate to your control system. Different rates of solid fertilizer can be sprayed by both solid fertilizer systems (such as spinners and pneumatic) as well as liquid sprayers, notwithstanding pressure constraints.

It’s possible to reduce environmental damage and save money by adopting this approach instead of uniform application (using fewer products). The use of maps or sensors in variable rate applications is also an option. According to an agronomist or consultant, several data sources are available for VRA prescription maps, which are subsequently utilized as the foundation for VRA applications. VRA has been planned out in advance. The use of electromagnetic induction to create prescription maps is expected to be both cost-effective and non-destructive. An applicator with sensors nearby may instantly calculate its variable rate in real-time, a feature called a sensor-based variable rate applicator (VRA).

A reduction in input costs may be achieved with fertilizer and seed that are applied precisely in the right place and at the right time, regardless of whether these costs are estimated for a single product or a range of items. As-applied maps may be generated using the Topcon controller X30 and X25 consoles, which allow users to input prescription maps. Farmers can alter the rate at which they administer crop inputs such as fertilizer, soil additives, irrigation, and agricultural pesticides using the variable rate (VR) approach. Implementing VR technology begins with an understanding that no two industries are the same and therefore do not require the same level of regulation (Verbeek et al., 2002). To formulate variable rate prescriptions, soil mapping and crop photography are standard methods of data collection (with ground-truthing). Virtual Reality (VR) technology sends just the right amount of information to the right place.

To make VR a reality, agricultural gear with built-in variable input controls and a GNSS receiver were combined. It is possible to alter the pace of agricultural inputs based on the crop’s or area’s variability. After soil and nutrient content is mapped out, fields are often separated into distinct “management classes” or “zones.” To create a prescription map, first, the application rates for each zone are determined, and then the VR controller adjusts product output in line with the prescribed map. Any chemical that is used to increase agricultural output might be considered an input. The majority of irrigation, fertilizer, lime/gypsum, and pesticide VR technologies have already been developed, yet this still holds. Soil mapping is frequently used to fine-tune application rates of soil amendments and fertilizers. If a low pH needs to be corrected, lime is used to raise the pH, and gypsum helps promote water penetration, the soil map is typically validated in the field.

To utilize a soil mapping layer as a prescription map, one must first assign rates to each of the map’s “zones”. Add the results from each of the management classes' sections to arrive at the overall product need. Prescription maps are put into the spreading equipment's VR controller. These maps have a wide range of accuracy distribution systems for virtual reality, VR controllers may be added to existing spreaders regularly. Installing this typically costs between $5000 and $6000; the price includes the labor costs. The construction business is increasingly utilizing virtual reality technologies. For virtual reality contracts, there are moments when the spread is akin to broadcast spreading (Terrones, 2003).

12.3 GPS

In conjunction with the Global Positioning System (GPS), precision agriculture, often known as smart farming, is now available. Precision farming has been used in the field (GIS). The ability to integrate real-time data collecting with pinpoint location data provided by these technologies makes it possible to handle and evaluate massive amounts of geographic data. Farm planning, field mapping, soil sampling, tractor navigation, crop scouting, variable rate applications, and yield mapping are just a few of the uses for GPS-based technology in precision agriculture. Farmers are now able to continue working in the field despite adverse vision, such as rain, dust, fog, and night, thanks to the invention of GPS devices.

Figure 12.3: GPS Farming.

Source: https://media.istockphoto.com/photos/modern-smart-farming-agriculture-technology-at-farm-picture-id1254095794?k=20&m=1254095794&s=612x612&w=0&h=lNZ1ZL6ZolZ68VMWCpYprJpZ0tyQzlu4E9Y7necsT4k=

Farmers had a hard time in the past matching crop yields and production methods to the soil's wide range of characteristics. Soil and plant treatment regimens that would have increased their total yield could not be developed because of this. By utilizing precision agricultural techniques, farmers can better control the dispersion of pesticides, herbicides, and fertilizers on their crops (Sismondo, 2018). Because of this, farmers can reduce their expenditures and boost their yields, while also creating more environmentally friendly farms.

In the wake of precision agriculture, farmers and agribusinesses are getting a whole new perspective on the land from which they make their money. Accurate soil, plant, and animal nutrient measurements, as well as site-specific treatment recommendations, are all part of precision agriculture. Increased agricultural output while safeguarding the environment are the primary aims of precision agriculture (PA). Although they have traditionally treated their fields equally, farmers are beginning to see the advantages of micromanaging their crops. Because of the development of high-tech agricultural equipment that is more precise, more helpful, and easier for the average person to operate, precision agriculture may have become more popular. On-board computers, data-gathering sensors, and global location and time reference systems like GPS are among the most recent technological advancements.

Many people believe that the full potential of precision agriculture can only be fulfilled by large farms that can afford to invest huge sums of money and have extensive expertise with information technology. That's not at all the case. Essential procedures and methods that don't cost a lot of money may be used by any farmer. Geospatial technologies like GPS, GIS, and remote sensing can provide the data needed to maximize the utilization of available land and water resources (Adamovich et al., 2017). Farmers may reap additional benefits if they increased their usage of fertilizer and other soil amendments, studied the cost-effectiveness of managing insect and weed infestations, and preserved the environment for future use.

Manufacturers of GPS technology have come up with a variety of solutions to help farmers and agribusinesses increase the productivity and efficiency of their precision farming operations. This page has the answers you're looking for. In agriculture, the use of GPS-enabled devices is becoming increasingly common. It is possible to construct maps of fields, roadways, irrigation systems, and agricultural problem areas such as weeds and disease with the use of GPS devices. Acreage measurements for field portions, road locations, and distances between areas of interest may be accurately mapped using GPS thanks to its high precision. Once a year, farmers may make a trip to specific areas to take soil samples and use GPS to assess the health of their crops.

The precise location of weeds, insects, and other pests in a field may be mapped by crop consultants using GPS-equipped data gathering equipment. Maps of agricultural pest hotspots can be created to aid in the development of future management plans and ideas for feedback. Human "flaggers" might be eliminated by using the same field data for aerial sprayers, allowing fields to be fully swathed. With the use of GPS, crop dusters can fly over the ground in exact patterns. Aside from lowering the amount of pesticide that is sprayed, this helps to safeguard the environment by ensuring that pesticides are only administered where they are needed. Using GPS, pilots can provide farmers with precise maps (Shannon et al., 2010).

Farmers and agricultural service providers could expect even more advancements in the realm of agriculture as GPS technology advances. Additionally, the United States plans to use GPS satellites to send a second and third civil signal, in addition to the basic GPS signal already in use today. The first satellite that would carry the second civilian broadcast was sent into orbit in 2005. Future farming operations will be more productive and of better quality thanks to the newly found signals.

12.4 YIELD MONITORS

Yield monitors are essential to the success of several site-specific management strategies. Yield maps are the graphical and mathematical output of yield monitors, and they allow for both creative inquiry and the generation of results that can be relied upon. The majority of agricultural supply shops stock yield monitors. Yield maps may be utilized to determine the degree to which regulated inputs like fertilizer, lime, seed, herbicide, drainage, and irrigation all affect the final product of the crop (Suryanarayana et al., 2001).

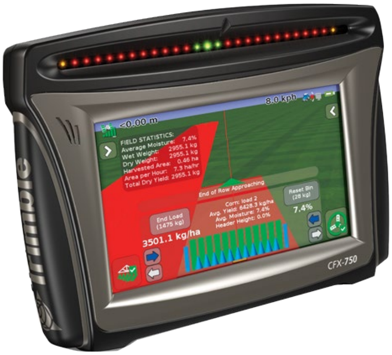

Figure 12.4: Yield Monitors.

Source: https://agriculture.trimble.com/wp-content/uploads/2019/03/yield-monitoring-trimble-ag-inset-1.png

It is in the best interest of the producer to use a yield monitor in conjunction with a combine that is fitted with a DGPS receiver. The data gathered by the yield monitoring system include, among other things, information on yield, grain moisture, and location. Additionally, it logs critical data to build yield maps.

A yield map will depict a wide range of agricultural production or productivity using a variety of hues and colours to illustrate the data. When yield maps are used, it is much simpler to comprehend the differences in yield throughout a field. It is recommended to investigate the soil as well as the other components of the field to see if there are any patterns of variation. It has been argued that yield maps are a confirmation of the memory that one ought to have had (yield maps validate the memories you should have had).

Utilizing examples as a learning tool is by far the most efficient technique to acquire knowledge concerning yield monitoring and mapping. According to the information presented in a research article, the typical yield for an acre of corn while cutting rows every 30 inches at a pace of five miles per hour is 120 bushels. The time it takes for the grain to go from the header to the grain tank on this combine is around 15 seconds (Swierstra & Rip, 2007). Yield monitors are reliable sources of information and can be counted on to provide consistent reporting on their results. In many different contexts, operators can select the level of data gathering that is performed (e.g. 1, 2 or 3-second intervals).

In this instance, it gathers data once every two seconds and has a resolution of 0.005 acres. Additionally, it takes an average of 200 yield measurements per acre and has a resolution of 0.005 acres. Yield monitors are superior to other types of precision agricultural equipment in terms of the number of data points they give.

The rate at which grain that is free of contamination is added to the storage tank is monitored by a yield monitor. It takes a significant amount of time from the point at which grain enters the header of the combine to the point at which it passes through the clean grain elevator because of the threshing and separating operations that are in place. As a consequence of this, the yield monitor calculates delayed averages of the yield by making adjustments for the quick variations in the yield.

The effects of delay and smoothing are particularly noticeable when a combine approaches or departs a crop at the field's extremes. This is because of the proximity of the combine to the crop. To receive an accurate or consistent reading from the yield monitor, the combine would need to travel a distance of 110 feet and harvest a fraction of an acre after a delay of 15 seconds (Small, & Klavans, 2014).

The majority of the time, yield mapping software can update yield figures so that they take into account the delays that are caused by combines. This yield map will not be perfect, but it will provide you with a sufficient amount of information to understand the scope and location of yield variance.

12.5 CROP SENSORS AND SOIL SENSORS

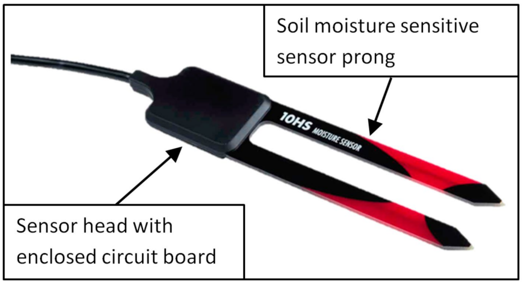
Soil moisture sensitive sensor prong
10HS MOISTURE SENSOR
Sensor head with enclosed circuit board

Figure 12.5: Soil sensors.

Source: Domínguez-Niño JM, Bogena HR, Huisman JA, Schilling B, Casadesús J. On the Accuracy of Factory-Calibrated Low-Cost Soil Water Content Sensors. Sensors. 2019; 19(14):3101. https://doi.org/10.3390/s19143101

This is a topic that has been discussed extensively for a very long time; it's one of the most pressing issues of our day, along with food quality and quantity, agricultural output, environmental impact, and the use of modern farming procedures that don't contaminate the environment. To get an edge in a sector known for its ruthless competition, farmers are increasingly turning to cutting-edge technology. There are several advantages to using the information to produce high-quality agricultural goods and operate efficient farms, as demonstrated by this example. It is equivalent to the information that is gathered by sensors in terms of advantages.

All farm equipment that may remotely collect data about one particular region is referred to as "sensors" in this context. Remote sensing is the term used to describe this technique (Alexander et al., 2006).

Modern remote sensing equipment does not have the same limitations that film photography did when it came to its possibilities. The current equipment can detect radiation, as well as light and heat. Various wavelengths of the electromagnetic spectrum are gathered to do this. Since their extensive use in agriculture, drones have grown more economical. Remote sensing devices assess the entire farm over a set period. With the use of sensors, the farmer can obtain a better knowledge of the state of his field, which in turn helps him make improvements that will lead to a higher yield in future crops. Sensors may be able to identify disease signals in crops, alerting farmers to take preventative actions before the sickness gets out of hand. It can count plants, calculate yields, regulate irrigation, identify and evaluate weeds, and map fields using remote sensing, among other fundamental duties, thanks to the usage of this technology.

Different sensors have a variety of functions to perform. According to the needs of the farmer and the goals, they aim to achieve in the end. Small-scale or subsistence farmers have different needs than big-scale or commercial farmers, who may have a large number of fields or a significant amount of land. It's up to the farm to select what sort of sensor it requires. A farmer must have a clear idea of what he wants to monitor and why he thinks a specific sensor will be advantageous to his style of crop management and his need to plan for the future.

An optical sensor may be used to examine soil properties by illuminating it with light. It is possible to determine a wide range of light reflectance frequencies in the near-infrared and mid-infrared regions of the polarized spectrum. Drones, satellites, and other aircraft can all benefit from these sensors. Examples of data that might be collected include the color of the plants and the reflectance of the soil.

Data from satellite radar and microwave sensors are more precise than weather forecasts when it comes to agricultural monitoring. In contrast to conventional sensors, which are designed to monitor just a small portion of the electromagnetic spectrum, certain sensors can detect a large portion of the spectrum (Banerjee & Williams, 2013). It all comes down to what the farmers want to achieve.

Hand-held electrochemical sensors are used to monitor soil pH and nutrient levels. Sensor electrodes analyze soil characteristics to carry out their duties. For the mapping of soil chemical information, it is required.

Soil's air permeability may be determined using airflow sensors, which are installed on the ground. While the individual is moving around, these measurements may be taken in real-time at specified points. It is necessary to examine the soil's properties such as compaction, kind, structure, and moisture content before planting. This was accomplished by first calculating the force needed to deliver a specific volume of air to a specific location on the earth's surface.

Sensor technology is always improving, and farmers will soon have to decide whether they will rely on trial and error approaches or those supported by research to help them boost yields and profitability over time.

CHAPTER 13

SCIENTIFIC TOOLS AND TECHNIQUES FOR MORE EFFICIENT ENGINEERING DESIGN

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Science is the systematic gathering of data used to investigate the natural world using the scientific method. Tools are made by integrating science and technology to solve problems and perform various tasks. Technology is the vehicle through which science is put into action. In actuality, distinguishing one from the other is impossible.

A rising number of distinct but interconnected endeavors fall under the broad categories of technology, innovation, and science. In general, science and technology have a six-way interaction (Rogers & Marres, 2000).

The discovery of previously undiscovered information drives technological innovation.

- Tools and techniques for developing more effective engineering designs, as well as a knowledge base for assessing the feasibility of numerous diverse concepts.
- Several approaches in various sectors eventually lead to the incorporation of research instruments and laboratory procedures into design or production operations (Rao & Cheetham, 2001).

Using research as a technique, new human abilities and skills relevant to a wide spectrum of cutting-edge technology may be produced and incorporated.

Create more significant data for evaluating technology in light of its larger social and environmental consequences.

- Increases the efficacy of applied research, development, and enhancement of new technologies through the generation of new information.

Technology has an equal impact on science since it supplies the techniques and equipment required to tackle difficult scientific issues more efficiently.

Figure 13.1: An infographic on tech in science.

Source: https://www.istockphoto.com/vector/pharmaceutical-medical-drugs-producing-at-factory-tiny-pharmacist-characters-at-gm1263965921-370074640?phrase=technology%20in%20science

Figure 13.2: Data from scientists being analyzed.

Source: https://www.istockphoto.com/photo/female-and-male-scientists-working-on-their-computers-in-big-modern-laboratory-gm949947128-259289252?phrase=technology%20in%20science

13.1 ANALYZING AND INTERPRETING DATA

Data analysis and interpretation have become more important in the digital era, and the volume of data can be overwhelming. Digital Universe found 2.8 quadrillion gigabytes of data in 2012. The capacity to analyze complicated data, produce meaningful insights, and adapt rapidly to evolving market needs will define a successful organization in the 21st-century global economy.

Digital business dashboards are big data tools. They can present quantitative and qualitative KPIs, which help industry executives make quick, data-driven market decisions (KPIs). Data dashboards help companies make quick, educated decisions through simplified visual communication. Let's define data interpretation to understand its importance (Porada et al., 2013).

Data interpretation involves utilizing analytical methods to examine data and draw conclusions. Researchers can classify, alter, and synthesize data using interpretation. Data interpretation is important; it must be done correctly. Data from many sources may be analyzed in random order. Statistics are often arbitrary. Firms' interpretation needs and goals depend on the type of data being reviewed. Quantitative and qualitative analysis are the most prominent sub-categories, however other methods may be used depending on the data.

Visual representations of data results are useless without a smart selection on measurement scales before successful data interpretation can begin. Before commencing significant data analysis, the scale of measurement must be decided, since it affects long-term ROI. Scales include:

Nominal scales are non-numerical, non-rankable categories. Variables limit and exhaust.

- Ordinal Scale: extensive, exclusive categories Ordinal scales measure quality and agreement (i.e., good, very good, fair, etc., OR agree, strongly agree, disagree, etc.).
- Interval: a measuring scale that organizes data logically and evenly. Zero is arbitrary.

Ratio combines all three.

After selecting measurement scales, evaluate which of the two main interpretation procedures will best meet your data needs. Let's analyze these unique data interpretation methodologies and issues(Badgujar et al., 2008).

An analyst must distinguish between correlation, causality, coincidences, and other biases while examining data and examining all relevant aspects. Data interpretation options abound.

Data interpretation helps people comprehend studied and presented numerical data. A systematic method (or processes) for examining data will provide your analytic teams a structure. Different departments may have incompatible aims if they assess the same data using different methodologies. Divergent tactics cost time and money through repeated attempts, uneven results, and energy. This section discusses qualitative and quantitative data interpretation.

13.1.1 Qualitative Data Evaluation

Categorical data analysis is qualitative. Qualitative analysis uses descriptive context to describe data, not numbers or patterns (i.e., text). Narrative data is collected using person-to-person procedures. These methods include:

- Observations: a description of group behavior. Patterns include activity length, nature, and communication mode.
- Focus groups: Organize people into groups and ask them research-related questions.
- Secondary research: Documentation sources may be classed and split by the information they offer, much like behavior patterns.
- Interviews are good for gathering narrative data. Responses to inquiries can be categorized by subject or category. Interviews segment data quite precisely.

Interpretation highlights the difference between qualitative and quantitative analysis. Since qualitative data is easily interpreted, it must be “coded” to make categorization easier. Notice, gather, and ponder about things sum up qualitative data analysis (Pahlavan & Makela, 2002). Person-to-person data collection may cause analytical conflicts.

13.1.2 Quantitative Data Interpretation

If quantitative data interpretation could be summed up in one word (and it really can’t) that term would be “numerical.” There are few certainties when it comes to data analysis, but you can be sure that if the study you are partaking in has no numbers involved, it is not quantitative research. Quantitative analysis refers to a collection of approaches through which numerical data is studied. More often than not, it necessitates the use of statistical models such as standard deviation, mean and median. Let's briefly examine the most popular statistics terms:

- Mean: a mean represents a numerical average for a group of replies. When working with a data set (or several data sets), a mean will suggest a center value of a particular group of variables. It is the total of the values divided by the number of values inside the data collection. Other terms that may be used to describe the notion include arithmetic mean, average and mathematical expectation.
- Standard deviation: this is another statistical word widely employed in quantitative research. Standard deviation displays the dispersion of the answers around the mean. It represents the degree of consistency among the responses; combined with the mean, it gives insight into data sets (Otsuka & Kakeshita, 2002).
- Frequency distribution: this is a measurement measuring the rate of a response appearing within a data collection. When applying a survey, for example, frequency distribution offers the capability of identifying the number of times a given ordinal scale response appears (i.e., agree, strongly agree, disagree, etc). Frequency distribution is very sensitive in detecting the degree of unanimity among data items.

Typically, quantitative data is reviewed by graphically illustrating correlation tests between two or more variables of interest. Different procedures could be done concurrently or individually, and comparisons can be made to finally arrive at a result. Other signature interpretation methodologies of quantitative data include:

- Regression analysis: Essentially, regression analysis analyzes historical data to determine the connection between a dependent variable and one or more independent variables. Knowing which components are connected and how they originated in the past allows you to foresee future results and make better judgments moving ahead (Nisbet et al., 2002). For example, if you want to anticipate your sales for next month you may use regression analysis to identify what aspects will affect them such as goods on sale, and the introduction of a new campaign, among many others.
- Cohort analysis: This approach discovers groups of users who have common traits throughout a certain period. In a commercial environment, cohort analysis is extensively utilized to evaluate

various client behavior. For example, a cohort may consist of all users who have signed up for a free trial on a certain day. An investigation would be conducted to evaluate how these users behave, what activities they carry out, and how their behavior varies from other user groups.

- Predictive analysis: As its name indicates, the predictive analysis approach seeks to foretell future trends by evaluating past and present data. Powered by technology such as artificial intelligence and machine learning, predictive analytics techniques enable firms to recognize patterns or imminent challenges and prepare intelligent solutions in advance.
- Prescriptive analysis: Also powered by predictions, the prescriptive analysis approach employs techniques such as graph analysis, complex event processing, and neural networks, among others, to try to unravel the influence that future decisions will have to change them before they are made. This allows companies to design responsive, successful business plans (Moore, 2013).
- Conjoint analysis: Typically used to survey analysis, the conjoint technique is meant to assess how individuals value varied elements of a product or service. This allows academics and organizations to decide the price, product attributes, packaging, and many other aspects. A typical implementation is menu-based conjoint analysis in which individuals are given a "menu" of possibilities from which they may design their perfect concept or product. Like technique analysts can understand the qualities they would prefer over others and push findings.
- Cluster analysis: Last but not least, cluster analysis is a method used to separate things into groups. Since there is no objective variable while conducting cluster analysis, it is an ideal tool to identify hidden trends and patterns in the data. In a corporate setting, clustering is used for audience segmentation to create personalized experiences, and in market research, it is typically used to establish age groupings, geographical information, and incomes, among others.

Now that we have seen how to interpret data, let's go further and ask ourselves some questions: what are some data interpretation benefits? Why do all industries participate in data research and analysis? These are essential problems, yet they often don't receive appropriate attention (MacIá, 2005).

13.2 THE SIGNIFICANCE OF DATA INTERPRETATION

Data collection and interpretation aid in making informed decisions. Data collection and analysis help businesses and newlyweds looking for their first home.

Data analysis and interpretation may include the following, regardless of technique or qualitative/quantitative state:

Data explanation

Data contrast

Outliers in data

Forecasts

Data analysis and interpretation improve procedures and identify problems. Growth and progress are impossible to achieve without fundamental data gathering and interpretation. Dependable is the keyword. Every institution and company has hazy performance-improvement goals. A notion will stall if it is not investigated and analyzed (i.e., minimal growth). What are some of the business advantages of digital data interpretation and analysis?

1) Informed decision-making: The quality of a choice is determined by its knowledge. Market leaders may be distinguished by data-driven decision-making. According to research, top-tier firms that use data-driven decision-making are 5% more productive and 6% more profitable(Martin, 2010). When a problem or goal is identified, the most decisive steps are taken. Identifying, developing, and communicating data for data analysis.

Institutions can solve real-world problems if they follow this simple procedure, which we should all be familiar with from grade school science contests. Cycles of informed decision-making This means that the process is never complete and that new issues and circumstances must be explored. Monitoring data discoveries will result in new data and goals.

Data insights provide information, and information is power. Analytics of market and consumer data can provide trends for connected market segments. Shazam demonstrates how data analysis may influence trend prediction. People can use the program to publish an unidentified song clip. Every day, 15 million song IDs are generated. Shazam's data aids in the prediction of popular musicians.

Recognizing market patterns may serve a greater purpose. Shazam's monitoring provides music executives and record label businesses with information about the current pop-culture scene. Data gathering and interpretation might help the sector anticipate the weather and improve market profits. Data should be collected, analyzed, and monitored by all institutions (Liu & Zhang, 2011).

Cost-effectiveness: Data analysis may assist firms in their sector in saving money. According to Deloitte, the ROI of data analysis is driven by successful cost reductions. Saving money is sometimes overlooked since making money is "sexier." Without the use of human capital, sound data analysis may alert management to cost-cutting opportunities.

Intel highlights the cost-cutting benefits of data analysis. Intel tested its chips approximately 19,000 times before releasing them in 2012. Intel saved money and time by using predictive data analysis. By focusing on certain tests, Intel avoids testing each chip 19,000 times. After adopting it in 2012, Intel saved $3 million. According to Intel, one of the most significant advantages of data analysis is cost reduction (Bøe et al., 2011).

Unmistakable foresight: Businesses that collect and analyze data get insight into their operations and performance. They are capable of detecting and resolving performance issues. Data visualization allows people to absorb information more quickly and make better business decisions.

13.3 PROBLEMS WITH DATA INTERPRETATION AND ANALYSIS

Some people who are skeptical about digital data discoveries believe that huge data indicates enormous damage. While examining data, data interpretation difficulties or "pitfalls" may develop, especially at the speed of thought. Let's look at some common data misinterpretation risks and how to avoid them.

1) Data analysts frequently confuse correlation with causation. The assumption is that two concurrent occurrences are linked. Actions can occur in the absence of a cause-and-effect relationship.
    - Assuming social media followers increase revenue in the digital era... There might be a relationship with today's multi-channel purchasing. That does not imply that more followers equal more money. Both direct and indirect

  causality are conceivable (Bernardes & e Albuquerque, 2003).
  - Make an effort to eliminate the variable that is causing the incidence.

2) Confirmation bias: Confirmation bias occurs when you have a theory or hypothesis in mind and only seek data patterns that support it.
   - In the digital era, supposing your employer asks you to look into a social media marketing campaign. When analyzing campaign data, you see that Facebook postings received a high share rate, whereas Twitter Tweets did not. Using only Facebook posts to determine the efficacy of a campaign is confirmation bias.
   - Solution: Because this problem is based on subjective desires, data should be evaluated by an objective committee. If not, resist the need to conclude until the evidence is thoroughly investigated. Never prove a concept, only disprove it.
3) Useless data is an issue of data comprehension in the digital age. Analysts will focus on irrelevant data as vast data is no longer centrally stored and rapidly reviewed.
   - In the digital age, you could see that while measuring the efficacy of an email lead generation campaign, homepage views increased but newsletter subscribers did not. The campaign was deemed successful based on homepage views, but no leads were generated (Lieber, 2003).
   - Proactively frame data analysis factors and KPIs before a data review. You don't need to track site visits if you're analyzing the performance of a lead generation effort through email subscribers. Concentrate on the variable that answers or solves your query, not on extraneous data.
4) Truncating an Axis: When creating a graph to analyze your analytic data, keep the axes as accurate as possible to prevent misleading images. Starting axes with wrong values may result in inaccurate conclusions.

The Y-axes in the picture below begin at 34%, making the difference between 35% and 39.6% appear considerably bigger than it is. This might lead to confusion about tax rates.

- Solution: Visualize your data carefully. Data confusion is avoided by respect and realistic axes. The Fox News chart with the proper axis values is shown below. This figure was created using Datapine's online data visualization tool.

Another common data analysis and interpretation difficulty is the small sample size. More samples imply more accurate and reliable results. This is determined by the magnitude of the research. A poll on the quality of education will have a different sample size than one on outdoor sports.

Assume you ask 30 people a question and 29 of them respond "yes," for a 95% response rate. Imagine asking 1000 individuals the same question and receiving 950 affirmative responses (95 percent). While these percentages appear to be the same, they do not represent the same thing because 30 people are insufficient to draw a valid conclusion (Breschi & Catalini, 2010).

- Solution: According to the researchers, to determine the best sample size for producing accurate and relevant results, a margin of error must be specified to indicate the highest amount they want the results to depart from the statistical mean. They must also have a 90-99 percent confidence level. Using these two numbers, researchers may calculate the exact sample size.

Researchers must evaluate dependability, subjectivity, and generalizability when interpreting qualitative data. Uncontrolled factors that might change qualitative study results could render it untrustworthy. This is compounded by the fact that the researcher chooses what is and is not relevant, and judgments may be subjective.

Another difficulty with qualitative research is generalizability. Because the data may be biased or unrepresentative of a wider population, drawing 100 percent representative conclusions is difficult with small sample sizes.

These variables influence both qualitative and quantitative research. Analysts may be biased when deciding which KPIs to display and how to display them (Liu & Ihl Woo, 2006).

Biased survey questions highlight the issues of dependability and subjectivity in the digital world. How was your interaction with our customer support team? The word "great" in the question alters the respondent's emotion. To avoid these errors, keep your research honest and impartial. Maintain objectivity in your inquiries. What was your opinion of our customer service? This will not direct respondents to a certain answer, guaranteeing accurate survey results.

13.4 METHODS OF DATA ANALYSIS

Data analysis and interpretation are critical for making informed decisions. As demonstrated in this article, data interpretation is both an art and a science. Some data interpretation strategies, methodologies, and tactics for a successful data management process are listed below.

As stated at the outset of this essay, the first step in successfully interpreting data is to define the type of analysis you will conduct. Separate qualitative and quantitative analyses (you lead research with a lot of numerical data to be analyzed through various statistical methods) (Kobayashi et al., 2019).

1) Inquire about data interpretation.

To begin, establish a clear baseline. Answering a few key questions can help with this. What's the point of my analysis? How will I assess the data? Who will use this data in the future? And what about the big question?

You can collect data after you've defined this information. Your data collection procedures will differ depending on the type of analysis you use (qualitative or quantitative). You can begin interpreting once you have all of the necessary data, but first, you must visualize it.

2) Make use of appropriate data visualization techniques.

Data interpretation requires graphs, charts, and tables. Data is more understandable and accessible when presented in interactive charts and graphs. As you may be aware, not all visualizations are suitable for analysis (Howe-Walsh & Turnbull, 2016). Using the incorrect graph can cause your data to be misinterpreted, so choose wisely. Let's look at some data visualization applications.

- Bar chart: This chart type displays the relationship between two or more variables using rectangular bars. The meanings of the horizontal, column and stacked bar charts differ.
- Line chart: A line chart shows how data changes over time, such as sales over a year, and is used to show trends, acceleration or deceleration, and volatility. Using too few variables can cause the graph to become crowded, so keep the axis scale close to the highest data point.
- Pie chart: Because of their simplicity, pie charts are used to show the proportional composition of a variable. A bar chart makes displaying a percentage more difficult visually than a pie chart. This is determined by the number of variables. If your pie chart requires ten pieces, consider using a bar chart instead.

- Tables: Tables, while not a type of chart, is used to interpret data. Tables can be used to display raw data. Individual values can be easily looked up or compared, and grand totals can be viewed.

As data visualizations become more important for businesses' analytical success, many tools have emerged to assist users in visualizing their data cohesively and interactively. BI dashboards are widely used. These visual tools group together a topic's graphs and charts(Hagendijk & Irwin, 2006). The role of dashboards in data interpretation will be discussed next. Learn more about data visualizations by reading our guide.

3) Maintain objectivity.

It is critical to keep your interpretation objective. It's easy to be subjective when looking at data when you're close to the investigation. Displaying the data to research partners or those who will use your findings can assist you in remaining objective. This can help to avoid confirmation bias and interpretation problems.

4) Compile your findings.

Observations are data-derived findings. They assist you in reaching more in-depth research conclusions. Trends and patterns discovered during interpretation can be considered findings. Use benchmarks from similar resources to contextualize your findings.

Consider your thinking and reasoning, and be mindful of data analysis pitfalls. Subjective bias, false information, incorrect data, and so on. You can draw conclusions, determine whether your initial question was answered, and make recommendations after interpreting the data.

13.5 DASHBOARDS AID IN DATA INTERPRETATION

The analysis of quantitative and qualitative data is distinct. Both provide varying returns on investment for data investigation, testing, and decision-making. Due to their differences, dashboards must be understood to bridge quantitative and qualitative information gaps. Digital data dashboards aid in bridging the data gap. Some examples:

Integration of data. Bulk data cannot be centralized at today's rate of innovation. As businesses become more global and borders dissolve, it will become increasingly important for them to conduct diverse data analyses without regard to location (Granato et al., 2014). Data dashboards decentralize data by combining quantitative and qualitative information.

Without making a decision, you can now measure customer trends and organizational performance.

Data on the go. The term “mobile data” refers to “connected and blended data.” In the digital age, employees spend less time at their desks and produce more. This is no longer possible because mobile analytical tools are no longer standalone. Today, mobile apps integrate with business tools. Data, both quantitative and qualitative, is now available on demand through interactive online dashboards.

Visualize. Data dashboards bridge qualitative and quantitative data interpretation through visualization. Dashboard solutions that work “out of the box” produce simple data displays. Color and filter patterns are available in modern online data visualization tools, which encourage user interaction and help predict future trends. All of these visual characteristics make switching between data methods simple; all you need is the right data visualization to tell your story.

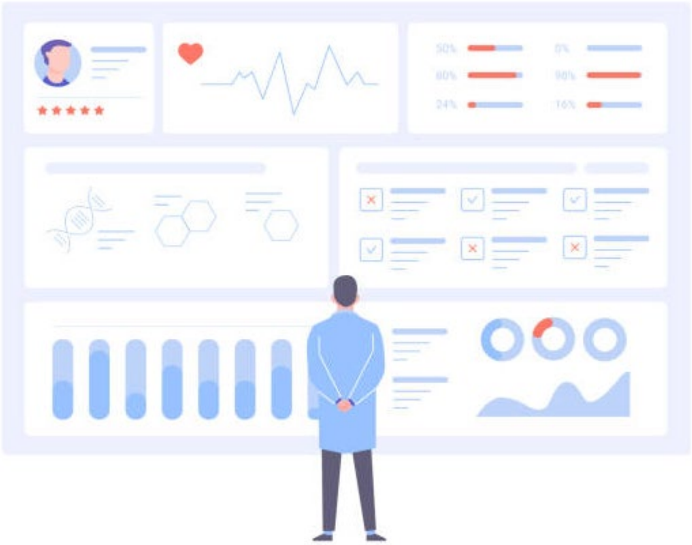

Figure 13.3: An infographic of a data dashboard.

Source: https://www.istockphoto.com/vector/a-male-doctor-is-standing-back-to-us-in-front-of-a-big-data-screen-gm1132225622-300057744?phrase=dashboard

The dashboard below demonstrates how visualization can help bridge quantitative and qualitative analysis and interpret research data. It combines carefully analyzed qualitative and quantitative data and visualizes it so that anyone can understand it.

Business dashboards include more examples of data analysis and interpretation. Data interpretation is critical. Dashboards bridge the information gap between traditional data interpretation methods and technology and can help to avoid major pitfalls in interpretation(Grupp & Mogee, 2004). They combine the best of the past and present as a digital age solution to maximize data interpretation ROI.

Figure 13.4: Various items in a data dashboard.

Source: https://www.istockphoto.com/vector/dashboard-ui-ux-kit-great-design-for-any-site-purposes-business-infographic-gm1315918172-403786511?phrase=dashboard

13.6 TABLEAU

For data analysis and business intelligence, a significant data visualization application is Tableau. Tableau was regarded as a leader in analytics and business intelligence by Gartner's Magic Quadrant. This Tableau webinar will cover a broad variety of how-to topics, such as how to construct various charts and graphs in addition to using Tableau's reports and dashboards to show data and deliver intelligent results.

Tableau is an excellent business intelligence and data visualization solution for reporting and analyzing massive volumes of data. It was developed in America in 2003, and in June 2019, Salesforce purchased Tableau. It supports users in developing a range of graphs, maps, dashboards, and stories to display and analyze data to aid in business decision-making (Gandini, 2011).

Figure 13.5: Data presented in a table.

Source: https://www.istockphoto.com/photo/all-on-time-informational-tableau-with-flights-arrival-schedule-in-the-airport-lounge-gm983099394-266891647?phrase=Tableau

Tableau is one of the most well-liked business intelligence software as it gives so many interesting, distinctive capabilities (BI) (BI) (BI) (BI). Let's explore some of the key Tableau Desktop features in more detail. Now that we are clear on what a tableau is, let's evaluate some of its key elements.

13.6.1 Features of Tableau

- Tableau delivers wide data discovery and exploration tools that allow customers to find rapid answers to key challenges.
- Users without prior knowledge of programming may get started straight away with making visualizations using Tableau.

- It may link to a range of data sources that are not supported by other BI tools. Users of Tableau may integrate and generate reports from multiple datasets.
- Tableau Server facilitates the management of all published data sources inside a corporation from a single place.

Figure 13.6: Data from an airport being presented.

Source: https://www.istockphoto.com/photo/all-on-time-informational-tableau-with-flights-schedule-in-the-airport-lounge-gm984172706-267091429?phrase=Tableau

13.7 RAPIDMINER

Rapidminer is a mining program.

Rapidminer is an all-in-one data science platform that lets you create and automate your workflows. This eliminates the need for us to write any programming for data mining. This is one of the most often used data mining tools (Ferrari et al., 2015).

Rapidminer's blank process user interface looks like this. In addition, it has a repository where we save our data. Data from our systems can be imported. It also provides us with several public datasets that we may experiment with. We are also capable of working with a database link.

13.8 R AND PYTHON

The next technological marvel is coming. Data Science and AI are leading. These two things make something we never dreamed possible. If you know this world, you know the two programming languages that are frequently debated.

R and Python are related programming languages. They're free and utilized in data science. Let's examine these languages' uses.

Python is an object-oriented, interpreted language. It has built-in data structures, dynamic typing (runtime type checks), and binding, making it a top language for application development. Python syntax is easy to read and learn (Bengisu & Nekhili, 2006).

Python and its libraries are free. Python improves programmers' coding efficiency. As it's interpreted, program debugging is trivial. It includes libraries like Scikit, Keras, Tensorflow, Matplotlib, NumPy, Pandas, etc. Jupyter Notebook, a live-code-sharing online program, makes data science discussions easy.

13.8.1 Python's Benefits

- It's a flexible language.
- It's well-organized, simple, and tidy.
- Python simplifies exploratory data analysis. Python is object-oriented, yet it uses functional characteristics to support diverse programming paradigms.
- Python is freely downloadable. It features one of the most active help forums, and anybody may improve libraries and functions.
- Python contains several data science-related libraries.
- Integration and control capabilities boost productivity.
- Python is embeddable.
- Python is compatible with C++.

Python drawbacks:

- Python is interpreted, hence it's slower than other languages.
- Python isn't compatible with iOS and Android. Developers say it's weak in this setting. It's usable with effort.
- Python is RAM-hungry. More things delay the process.

- Python's database access layers are immature compared to JDBC and ODBC, making them less used.
- Python's Global Interpreter Lock hinders threading or simultaneous function flow (GIL).

R is a statistical/computing/graphics programming language. R includes linear and nonlinear modeling, statistical testing, clustering, etc. R's strength is how easily it can plot mathematical notations and formulae (Ferguson & Zhang, 2002).

R is free. UNIX, Windows, and macOS build it. R lets developers add user-specific functions. The user can connect C and C++ during runtime for heavy activities. R packages can add C++.

13.8.2 R's Benefits

- R is a free, open-source programming language.
- R works on UNIX, Windows, and Mac.
- R's read and dplyr packages can organize messy code (Floros et al., 2010).
- R makes plots and graphs using ggplot and plotly.
- R offers several packages for machine learning, data analysis, and statistics.

13.8.3 R's cons

- R uses more memory since all items are stored physically. The application lags as the data grows.
- R lacks fundamental security, making it hard to incorporate into online apps.
- R is a tough language to learn, unlike Python.
- R runs slowly. Output is slower than with MATLAB and Python.
- R demands all data to reside in one location, making data management onerous. Big Data isn't ideal. The integration makes handling easier.

13.8.4 Comparisons

Python and R are popular in Data Science, Data Analysis, and Machine Learning. Despite having comparable uses, they're different. Python is versatile in its application and data processing jobs, whereas R concentrates on statistics (Bell & Lederman, 2003).

R is an excellent graphing tool. R's undeveloped production capabilities make it difficult to utilize in a production context, however, Python is easily integrated.

Python performs quicker than R in all settings. Both languages are popular for different uses.

Figure 13.7: An infographic on R and python.

Source: https://www.istockphoto.com/vector/r-letter-logo-with-snake-head-silhouette-gm1251979585-365452677?phrase=r%20and%20python

13.9 MICROSOFT EXCEL

Excel stores, analyzes, sorts, and reports data. Spreadsheets are popular since they're visible and straightforward.

Business analysis, HR management, performance reporting, and operations management are popular Excel applications. Statistics prove it (using MS Excel).

Excel's main use is business analysis.

The business analysis informs decisions. Businesses track daily sales, internet traffic, supplier costs, and insurance claims (Foest et al., 2006).

Through company analysis, executives gain essential data. You may create a daily profit report. Management can exploit the business's Sunday losses (such as closing on Sundays).

Business analyst, business solutions analyst, claims analyst, collections analyst, credit officer, and senior portfolio analyst.

13.9.1 Recruiting

Excel is often used to manage employees.

MS Excel organizes employee, client, supporter, and training participant data.

Excel is a dependable data-storage tool. Name, email address, employee start date, things purchased, subscription status, and last contact are in a spreadsheet row or column.

Reconciliation and payments officer, relationship manager, HR administrator, HR administrative assistant, HR adviser, HR officer, and junior HR analyst. Growth strategist. Customer service. Account manager. Service expert. HR consultant (Dhillon et al., 2017).

13.9.2 Operations/administration

Excel is used daily by enterprises.

Logistics may be challenging. Controlling inventory flows maintains efficiency and prevents overstocking. Tracking dates, deadlines, and supplier and client transactions.

Amazon employs proprietary software for operations management, whereas smaller companies use Excel (or parts of larger businesses). Excel's low-tech nature allows many users to avoid programming errors.

Business operations analyst, data operations manager, operational business analyst, operational enablement associate, operational knowledge management expert, supply chain associate, and supply chain specialist.

13.9.3 Accountability

Excel can track and report performance. Many accountants still use Excel since it's cloud-compatible.

Excel pivot tables provide performance reports. A pivot table can help you rapidly extract relevant data. Pivot table count and total tools are built-in (Doi, 2006).

Accountant, performance analyst/procurement, operations analyst for professional services, operations analyst for reporting, and sales coordinator.

13.9.4 Administration

Office administrators keep administrative data in Excel, highlighting its relevance. Performance reporting, accounting, finance, and business analysis use the same data.

Bill payment, invoicing and communicating with suppliers and consumers all require Excel. It's flexible office management.

Office manager, officer, junior clerical and administrative officer, office admin manager, and general office support..

Strategic analysis impacts business decisions with Excel formulas and data. Excel guides investment and asset allocation (Cao et al., 2006).

Using Excel, you could get FX insurance. Spreadsheet analysis affects business decisions.

Portfolio manager - real estate management division, M&A values analyst, membership and campaigns strategist, and portfolio administration associate.

13.9.5 Administration

Even with PM tools, an Excel workbook could help.

Projects have dates and costs. Workbooks help keep projects on track and on time.

Excel makes sharing project workbooks easy, even without PM tools.

Business analysts, officers, and assistants are examples.

13.9.6 Programming

Excel manages software well. Controls software details. Microsoft Excel's widespread use makes program records easy to handle and transfer.

A program is like a project, but it's ongoing and requires user input. Excel lets managers allocate resources, track progress, and store participant data (Chadwick et al., 2011).

Events coordinator, L&D officer, L&D coordinator, internship manager, office/program/records/results coordinator, and training administrator.

Figure 13.9: Data presented in excel.

Source: https://www.istockphoto.com/photo/plotting-their-progress-thus-far-gm176201166-26374790?phrase=excel%20spreadsheet

13.9.7 Procurement

Dates, deadlines, deliveries, and payments can be tracked in MS Excel.

Contract management templates can change contract type or lifecycle stage.

Contract administrator for construction, estimators, leasing, quotes, and tenders.

13.10 ACCOUNT MANAGERS MUST USE EXCEL TO TRACK CUSTOMERS

Account managers contact current customers. Customer loyalty is crucial. Marketing MBAs are common.

Excel distributes and stores client files in account management.

Account Coordinator, advertising manager, design account manager, junior account manager, and digital account manager(Borup et al., 2006).

MBA Excel

Excel knowledge helps the company.

Excel jobs are often "medium skill." Excel is common. Spreadsheet skills can help with many tasks. A workbook has easier-to-use information.

Mastering Excel will be useful. It supports simple and complex commercial transactions.

Figure 13.8: A person using an excel worksheet.

Source: https://www.istockphoto.com/photo/woman-working-with-data-and-graphs-in-spreadsheet-document-on-desktop-computer-gm1317928013-405212760?phrase=excel%20spreadsheet

Figure 13.10: An infographic of an excel worksheet.

Source: https://www.istockphoto.com/vector/download-xls-icon-xls-file-with-down-arrow-symbol-downloading-spreadsheet-document-gm1251414268-365210352?phrase=excel%20spreadsheet

13.11 KNIME

Open-source data analytics, reporting, and integration platform. KNIME's "Building Blocks of Analytics" idea combines ML and DM. A graphical user interface and JDBC enable modeling, data analysis, and visualization without or with no code. Pharmaceutical research, CRM customer data analysis, business intelligence, text mining, and financial data analysis employ KNIME. RPA uses KNIME. Zurich, Konstanz, Berlin, and Austin (USA) are KNIME offices (USA).

University of Konstanz software developers started KNIME in 2004. Michael Berthold's team was from a Silicon Valley software firm. The objective was to design a modular, highly scalable, open data processing platform for collaboration, research, and data integration (Zhang et al., 2018).

Pharmaceutical industries and life science software suppliers started utilizing KNIME in 2006. Over 15,000 genuine users (not including downloads but users who routinely obtain updates) in health sciences, banks, publishers, auto manufacturers, telcos, consulting firms, and other businesses utilize KNIME as of 2012. KNIME supports Apache Spark

2.3, Parquet, and HDFS. Gartner's Magic Quadrant for Data Science and Machine Learning Platforms includes KNIME.

KNIME lets users visually design data flow (or pipelines), choose to perform analytic processes and analyze findings, and models, using widgets and views. Eclipse-based KNIME uses Java. It uses plugins to extend features. The core version includes hundreds of modules for data integration (file I/O, database nodes supporting all common database management systems through JDBC or native connectors: SQLite, MS-Access, SQL Server, MySQL, Oracle, PostgreSQL, Vertica, and H2), data transformation (filter, converter, splitter, combiner, joiner), statistics, data mining, analysis, and text analytics (Zeldin et al., 2008). Free Report Designer extension provides visualization. KNIME workflows may be used to build report templates in doc, ppt, Xls, pdf, and other formats. KNIME can also:

- KNIME's core architecture supports enormous data volumes limited solely by hard drive capacity (not RAM) (not limited to the available RAM). KNIME analyzes 300 million client addresses, 20 million cell pictures, and 10 million chemical structures.
- Plugins allow text, image, time series, and network mining.
- KNIME incorporates open-source applications such as Weka, H2O.ai, Keras, Spark, the R project, and LIBSVM; plotly, JFreeChart, ImageJ, and the Chemistry Development Kit.

KNIME is written in Java, but it has wrappers that call other programs and nodes that run Java, Python, R, Ruby, and another programming.

13.12 POWER BI

Microsoft created Power BI. With Microsoft's "Power BI," you can examine data and share insights across your organization, app, or website. Exploiting each piece's distinct qualities and how they interact adds value and adaptability. Dashboards, reports, and Power BI apps may be accessed via a web browser or mobile apps for Windows, iOS, and Android. Power BI is a cloud service provided by Microsoft (Wu et al., 2019).

Power BI Desktop is a free software for analyzing and producing reports on Windows. Connects to over 70 on-premises and cloud data sources to generate dynamic graphics. Data scientists and developers utilize Power BI Desktop to produce and share reports.

Users can do the following:

Data-connect

- Model-generated data
- Create graphs and charts

Reports and dashboards are shown.

Power BI reports may be distributed to others.

13.13 USING MATHEMATICS AND COMPUTATIONAL THINKING

Computational math places a premium on algorithms, numbers, and symbols. Computational mathematics encompasses all areas of mathematics and science in which computers play an important role.

Computational applied mathematics use mathematics to improve the performance of computers. Computerized arithmetic computations are referred to as “computational mathematics.” This includes using computers to perform mathematical calculations (computer algebra), examining what can and cannot be automated in arithmetic (effective procedures), and determining whether mathematical computations can be performed with current technology (complexity theory) (proof assistants) (Woolgar & Lezaun, 2013).

13.13.1 Applications of Mathematics

In the 1950s, computational mathematics emerged as a field of applied mathematics. Computational math entails:

- Engineering or computational science
- Using computer simulations to solve math problems rather than analytical procedures.
- Scientific computation techniques such as linear algebra and PDE solutions
- Monte Carlo techniques and other stochastic approaches for simulating the uncertainty in scientific computation
- Scientific mathematical formulas.
- Numerical approaches and analysis
- Difficult math
- Algebraic computing systems
- Study of computation algebraic topology, discrete mathematics, combinatorics, and automated theorem proving using computers.

- In cryptography and computer security, elliptic curves, factorization, primality testing, and blockchain mathematics (Antal & Grønli, 2003).
- Computational linguistics investigates natural languages using computers and mathematics.
- Algebraic Geometric Computation
- Math in groups
- Geometry with a computer
- Compilation
- Networking
- Calculations based on statistics
- Algorithms for data
- The idea for a game
- Math is used in accounting and finance in mathematical economics.
- Mathematical experimentation

Figure 13.11: An infographic on mathematics.

Source: https://www.istockphoto.com/vector/math-science-concept-tiny-male-and-female-students-characters-in-lab-or-school-gm1253077450-365840004?phrase=mathematics

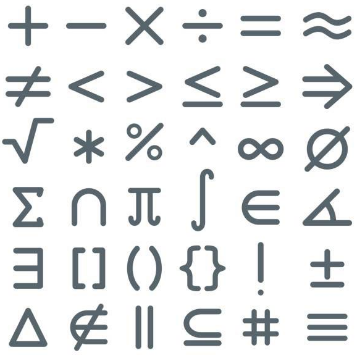

Figure 13.12: An infographic on mathematics symbols.

Source: https://www.istockphoto.com/vector/math-symbols-mathematic-icon-set-gm842986262-137639905?phrase=mathematics

CHAPTER 14

TECHNOLOGY FOR MORE EFFICIENT PRODUCTION OF GOODS AND SERVICES

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Technological improvements have had a tremendous impact on businesses, allowing them to improve upon and establish whole new methods of creating their products. Technology helps businesses because it improves output, ensures product quality, and lowers production costs (Wang, 2009).

The goal of most firms is to use technology in such a way that the possible downsides are minimized.

Figure 14.1: Aerial view of solar panels.

Source:https://media.istockphoto.com/photos/aerial-view-of-solar-panels-on-factory-roof-blue-shiny-solar-photo-picture-id1354581999?k=20&m=1354581999&s=612x612&w=0&h=MEYWs6Qja7A43J0u7LcF1MMjH1Y_I8PZK-GTn9sKQ0qE=

Even while the initial investment in technology is high, the decreased production costs more than balance this. Businesses can save money on the higher wages associated with dangerous jobs by replacing human labor with machines. As a result, expenses are lowered and worker well-being is boosted.

Productivity increases can be obtained via the mechanization or automation of various phases of manufacturing. To stay in business, a company can either raise prices or increase profit margins.

Businesses must maintain a standard of consistently superior product quality. Machines and robots can help with several different types of work in the manufacturing sector.

- Adaptability (to both technology and human change) - Businesses typically need to establish a comfortable medium between these two extremes. Automation is fantastic for large manufacturing, but it doesn't work well for personalized products (Wynne, 2007). Luxury automobiles provide a wealth of customization possibilities, some of which may involve hand-finishing for the customer's pleasure.

14.1 COMPUTER-INTEGRATED MANUFACTURING (CIM)

It's the method of using computers to monitor and manage every step of the production process in a factory. This fusion makes it easier for separate operations to talk to one another. Manufacturing processes may be streamlined and improved with the use of computers. Methods of closed-loop control that utilize in-the-moment sensor data are frequently used in CIM. The term "flexible design and production" describes this practice.

The aerospace, automotive, aviation, and maritime sectors all use computer-integrated production methods.

Figure 14.2: Electronic circuit boards plant.

Source:https://media.istockphoto.com/photos/electronic-circuit-boards-plant-picture-id1219441780?k=20&m=1219441780&s=612x612&w=0&h=Y_wic-1foVEKvxpUzKH2_ReCi-5eqy1AQglFd_vK7lLA=

The term "computer-integrated manufacturing" (CIM) refers to both a manufacturing approach and a computer-automated system that works together to streamline a company's engineering, production, marketing, and support functions.

Design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are just some of the business operations that may be streamlined with the use of a computerized manufacturing information management (CIM) system.

CIM is a prime example of how ICT may be applied in the industrial sector.

Information and communication technologies (ICT) are increasingly being used in the industrial sector, and CIM is one such example. The common Information Model (CIM) denotes the presence of at least two computers that exchange information, such as a robot arm controller and a microcontroller. When a firm or facility employs a great deal of information and communication technology, such as computer-aided design and manufacturing (CAD/CAM) systems and the availability of process planning and associated data, CIM may be especially useful (Woellert et al., 2011).

14.2 CHALLENGES TO CREATING A COMPUTER-INTEGRATED MANUFACTURING SYSTEM

Difficulties can arise due to the integration of several suppliers' parts when autonomous machines like CNCs, conveyors, and robots all utilize their unique communications protocols (and in the case of AGVs, even their unique charging times). The importance of the information utilized to operate automated systems grows in tandem with the degree of automation present. Although the CIM system lessens the amount of human effort needed to run the machines, safeguarding the data signals used to control the machines still necessitates additional work from humans. While computers may be utilized to help manufacturing plant operators, a professional engineer should always be on standby in case of any unforeseen problems.

- Subsystems

Although a computer-integrated production system is not the same as a "lights-out factory," which requires no human oversight whatsoever, it does get us much closer to that ideal. Modifying the factory's setup to make a different product takes little time, and the production run's quota may be modified in a flash with the use of computers; this is an example of flexible manufacturing, which is a part of the system. The following components are optional in a CIM operation:

Computer-facilitated methods:

- CAD (computer-aided design) (computer-aided design)
- Engineering helped by computers (CAE) (computer-aided engineering) (computer-aided engineering)
- CAM (computer-aided manufacturing) (computer-aided manufacturing)
- CAPP signifies computer-assisted process planning (computer-aided process planning)

Computer-assisted quality control (CAQ

- Planning and control of production (PPC) ERP stands for enterprise resource planning
- A network of business systems connected by a shared database.

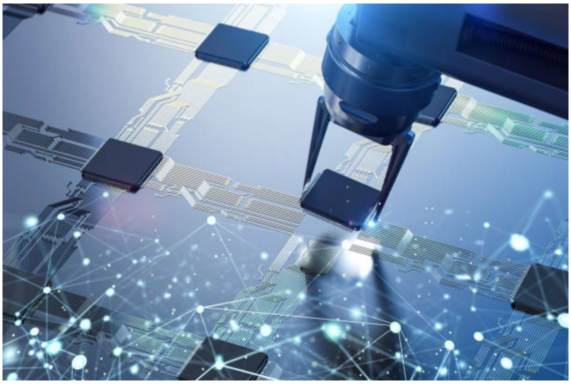

Figure 14.3: Robotic arms.

Source:https://media.istockphoto.com/photos/3d-rendering-robotic-arms-with-chipset-for-semiconductor-picture-id1370212104?k=20&m=1370212104&s=612x612&w=0&h=-VhVj4hfRkn1S2JOBh8GFcUEkAIEThpjopzezHsxmY0=

Required devices and equipment:

- CNC refers to machine tools that are computer numerically controlled.
- Machines employing direct numerical control (DNC)

- Programmable logic controllers (PLCs
- Automation
- Desktop computers
- Computer programs
- Supervisors
- Networking
- Communication
- Monitoring devices

14.3 COMPUTER-AIDED DESIGN (CAD)

Simply described, computer-aided design (CAD) is the use of computers (or workstations) to aid in the design process at any level (CAD). This program improves design workflow, design output, cooperation through documentation, and the creation of manufacturing databases. When included in patent applications, CAD drawings help to protect commodities and inventions. Computer-aided design (CAD) commonly produces digital files that can be utilized in printing, machining, and other production processes (Whitcombe et al., 2014). Also used are the words computer-aided design and drafting (CADD) and computer-aided drawing (CAD).

Figure 14.4: House project in virtual.

Source: https://media.istockphoto.com/photos/house-project-in-virtual-reality-picture-id1351472483?k=20&m=1351472483&s=612x612&w=0&h=VpjigEQ1NMEsfZ_WVDICmgW-7h4u87XL4Nm8a1PgUqM=

The term "electronic design automation" refers to the routine use of computers to aid in the design process of electronic systems (EDA). MDA is an abbreviation for "mechanical design automation," which is how a technical drawing in the field of the mechanical design is created.

In mechanical design CAD software, vector or raster pictures that depict the overall appearance of the anticipated goods are utilized to illustrate the traditional drawing elements. However, there is more to it than just geometry. Output from computer-aided design software, like hand-drawn technical and engineering drawings, must convey information about materials, methods, and tolerances in a way that is compatible with the needs of the application.

Computer-aided design (CAD) software can be used to create two-dimensional (2D) curves and figures, as well as three-dimensional (3D) curves, surfaces, and solids.

Computer-aided design is used extensively in a wide range of disciplines, from automotive and aerospace to BIM (building information modeling) and industrial design to prosthetics (CAD). The phrase "digital content creation" (DCC) refers to the practice of employing computer animation to create visual effects in media such as movies, advertising, and instructional manuals. Because of the pervasiveness and power of computers in modern civilization, perfume bottles and shampoo dispensers are now manufactured using techniques that engineers in the 1960s would find incomprehensible. CAD has been a major stimulus for the study of computational geometry, computer graphics (both hardware and software), and discrete differential geometry due to its significant economic impact.

Photographic simulations, which are frequently required in environmental impact studies, can also be created with CAD. By superimposing computer-aided drawings of the buildings over images of the current surroundings, these simulations depict the site as it might seem if the proposed facilities were erected (Verbeek et al., 2002). The most prevalent application of CAD is to study shadow studies and potential view corridor interference.

Figure 14.5: Syringe detail.

Source:https://media.istockphoto.com/photos/syringe-detail-picture-id1334646166?k=20&m=1334646166&s=612x612&w=0&h=6kMV_eUNYKEvXfM-RxMI3BkJ1ImDDF_KmeREJsWBw2rg=

Engineers have had success using CAD. To do this, we employ four criteria: prior experience, current features, future parameterization, and final limitations. The model's construction history can be examined attribute by attribute, allowing you to focus on a specific element rather than the whole. Parameters and constraints can be used to specify the dimensions, shapes, and other features of many modeling components. Tensile strength, yield strength, electrical properties, and electromagnetic property measuring equipment can all benefit from the capabilities of the CAD system. The stresses, strains, ages, and temperatures that an element undergoes must all be considered.

There are numerous types of computer-aided design software and each one necessitates a specific methodology for the construction of digital models.

Many low-cost 2D system vendors also offer their software in a free and open-source manner. Because they may be altered as needed during the final draft development, these allow you to create without the headache of hand drafting in terms of scale and location on the drawing page.

Wireframes in three dimensions are just the third dimension of a two-dimensional drawing (not often used today). All of the lines in the drawing must be modified individually. The finished product has no mass and cannot contain any elements that add mass to it, such as air. Many 3D systems allow you to use the wireframe model to build the final engineering design views, but their purpose is identical to that of 2D systems (Terrones, 2003).

The method of creating 3D "dumb" solids is quite similar to dealing with actual objects (not often used today). Adding and removing solid volumes from simple three-dimensional geometric constructions simulates the formation and slicing of real-world objects (such as prisms, cylinders, spheres, and rectangles). Models can be used to quickly create two-dimensional projected views. Basic 3D solids frequently lack the properties essential to allow component motion, govern that motion, and identify component interference.

Figure 14.6: Automotive engineers.

Source: https://media.istockphoto.com/photos/team-of-automotive-engineers-working-on-desktop-computers-in-modern-picture-id1353796978?k=20&m=1353796978&s=612x612&w=0&h=fS22iIYmanXyXgnV297zLA0dz-bOcPyvwvH3z897IYKo=

14.4 3D SOLID MODELING

- The operator can employ "design intent" in parametric modeling. Things are malleable due to their fundamental nature and characteristics. Future changes can be done by simply changing the construction of the first component. If features were initially supposed to belong in the middle of the part, the operator must arrange them in the model from there. Using any arbitrary geometric feature of the part would be a violation of the design's intent, yet the feature may be located using any of them (Sismondo, 2018). If the component is designed with this capability in mind, the operator can make changes while still retaining the geometric and functional relationships of the component.

- Geometry in a model can be changed directly or explicitly without the need for a revision history tree. Geometry is created through direct modeling by sketching a new shape and connecting it to an old one. The designer can make modifications to the geometry without having to return to the drawing. Like parametric modeling, direct modeling can include links between specified geometries (e.g., tangency, concentricity).
- Thanks to recent technological advancements, designers may now add more natural, visually pleasant, and ergonomic qualities to their creations. Creating items that are both visually pleasing and operationally appropriate for the human form and machine interaction frequently necessitates integrating the use of solids with freeform surface modeling.
- Associative links in technology enable a new type of prototyping called digital prototyping. Virtual prototypes can be generated without delaying production, unlike physical prototypes, which require manufacturing time throughout the design phase (Shannon et al., 2010). To counteract this, when a CT scanner has scanned a physical prototype, a computer can generate CAD models. Depending on the demands of the company, prototypes might be digital or real.

The computer mouse is the most typical HMI, however, pens and graphics tablets can also be utilized. On occasion, the model's screen view can be changed using a Space mouse or SpaceBall. Stereoscopic glasses, which are provided with some systems, can be used to view the 3D model. Technologies that were previously only available in large-scale installations or by specialists are now available to regular users. This notion is shown through the usage of motion detectors and CAVEs, two instances of interactive technology (head-mounted displays).

14.5 SOFTWARE

From single-family homes to skyscraper factories, CAD software is essential for the drafting and design of all types of buildings (hospitals and factories).

Although computer-aided design (CAD) is most commonly used in the detailed engineering of 3D models or 2D drawings of actual physical components, it is also used throughout the engineering process, from the initial conceptual design and layout of a product to strength and dynamic analysis of assemblies to the definition of component manufacturing methods. Other items that can benefit from its use include jewelry, furnishings, and electrical devices (Suryanarayana et al., 2001). Furthermore, many CAD software systems now have superior rendering and animation capabilities, allowing engineers to see their product conceptions more vividly. 4D BIM, a type of virtual simulation used in construction engineering, includes data for project management connected to time or schedule.

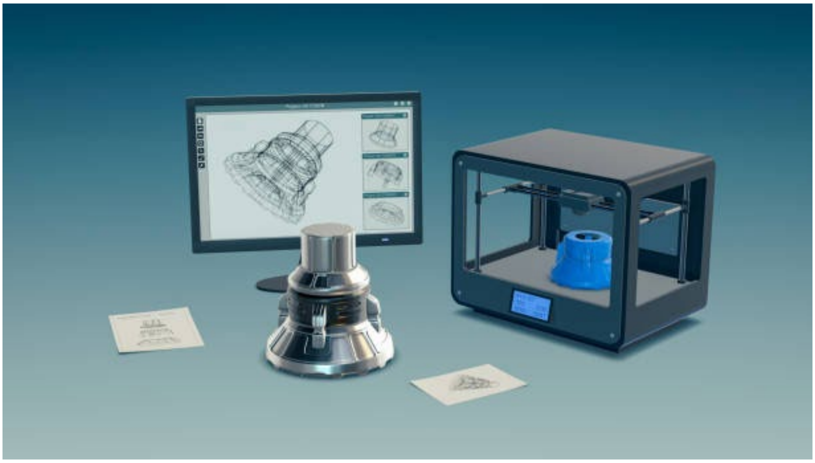

Figure 14.7: Sketch of the final product.

Source: https://media.istockphoto.com/photos/from-sketch-to-final-product-picture-id1305929733?k=20&m=1305929733&s=612x612&w=0&h=_8uDmKNKl9ESmXnht1eMLpd77NO1murqEDo0rxMOmA0=

CAD has grown in importance within the area of computer-aided technology due to its numerous advantages, including quicker design cycles and cheaper product development costs. Designers may speed up the drawing process by using CAD to create and develop their work digitally, print it out, and save it for later evaluation.

14.6 COMPUTER-AIDED MANUFACTURING (CAM)

Software controls machine tools to generate manufactured goods in computer-aided manufacturing or CAM. C.A.M. is an abbreviation for computer-aided modeling, which also refers to computer-assisted machining. The most common definition of CAM is the use of computers to assist in all stages of manufacturing, from initial concept to finished product. Its primary purpose is to increase output while decreasing energy usage and material waste. In terms of size and material consistency, components and tools are also being created with higher precision. CAM is being employed in both secondary and higher education settings (Swierstra & Rip, 2007). Because the CAD and CAE models can be entered into CAM software, which controls the machine tool, computer-aided manufacturing (CAM) is the next computer-assisted process. Academic institutions make extensive use of computer-aided design (CAD) and computer-aided manufacturing (CAM).

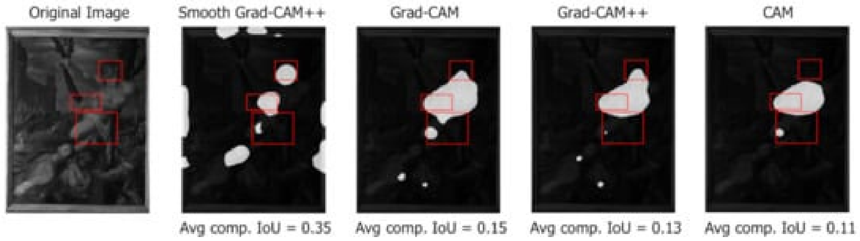

Figure 14.8: CAM in art.

Source: Pinciroli Vago NO, Milani F, Fraternali P, da Silva Torres R. Comparing CAM Algorithms for the Identification of Salient Image Features in Iconography Artwork Analysis. Journal of Imaging. 2021; 7(7):106. https://doi.org/10.3390/jimaging7070106

CAD was once assumed to be used exclusively to build two-dimensional or three-dimensional models of components for use in CAM, a numerical control (NC) programming approach. CAM has not had the same impact as other “computer-aided” technologies in terms of reducing the need for manufacturing engineers, NC programmers, and machinists. CAM raises the value of the most skilled production workers while simultaneously improving the competency of up-and-coming specialists in the disciplines of visualization, simulation, and optimization by utilizing cutting-edge production technology.

In most circumstances, a CAM tool will convert a model into G-Code, a language that the intended machine understands. In 3D printers and, more recently, milling machines, numerical control has been applied. The efficient transfer of CAD data is required for the integration of CAD with other CAD/CAM/CAE PLM components. It was usual practice to require the CAD user to save the file in a common format such as IGES, STL, or Para solid before the data could be used elsewhere. CAM applications frequently generate a text file containing G-codes or M-codes, each of which may include hundreds of commands (Small, & Klavans, 2014). The data is subsequently sent to the machine tool via DNC software or, in newer Controllers, a standard USB Storage Device.

CAM software has never been able to reason as effectively as a machinist. They were unable to significantly optimize manufacturing toolpaths. The machining method, tool type, and cutting routes would be determined by user input. Even if an engineer is skilled in G-code development, optimization and wear issues will occur with time. Objects that require machining, in the beginning, are frequently mass-produced using casting or other non-machine techniques. This allows for the creation of simplified, highly effective G-code that would otherwise be impossible to generate using traditional computer-aided manufacturing (CAM) technologies.

Figure 14.9: Automotive diverse engineers.

Source:https://media.istockphoto.com/photos/young-diverse-team-of-automotive-engineers-working-in-office-at-car-picture-id1353796808?k=20&m=1353796808&s=612x612&w=0&h=tIMZ3wSaDFu4JiuirKSBlXVpZyhpu-wRWJD0qk8kXBpU=

As CAM software and equipment get increasingly complicated, the competencies required to be a machinist or machine operator will eventually mirror those of a computer programmer and engineer, rather than removing CNC machinists from the industry.

Frequent sources of concern:

- High-Speed Machining, which includes simplified tool paths
- Multifunctional Machining Aspects
- Milling with several axes
- Detection of features and machine processing of such data
- Using a computer to automate the milling process
- Convenience
- Overcome one's previous shortcomings

Manufacturers of specialist solutions, as well as high-end solution providers, are attempting to address the shortcomings of CAM's history. There are three major areas where this is occurring:

- The simplicity of use
- The second level of difficulty is in production.
- PLM expansion and corporate integration
- Very simple to use
- Process wizards, templates, libraries, machine tool kits, automated feature-based machining, and job-function-specific, customizable user interfaces help new CAM users quickly achieve proficiency(Rogers & Marres, 2000).
- When the interface with the 3D CAD environment is more robust, thanks to technologies like error-avoidance simulations and optimizations, users are more inclined to trust 3D visualization.
- Industrial technology has been developed.

In the manufacturing environment, complexity is increasing. Production engineers, NC programmers, and machinists require CAM and PLM tools in the same way that a modern airplane pilot requires computer assistance. This is required for modern machines to function properly.

Figure 14.10: Industrial technology concept.

Source:https://media.istockphoto.com/photos/industrial-technology-concept-female-engineer-working-in-the-factory-picture-id1315733319?k=20&m=1315733319&s=612x612&w=0&h=Rh0ziVvugIvC7TPQxv8d1Nb4Brdup-p7vil1McT7OENk=

Turning, 5-axis machining, waterjet, laser, plasma cutting, and wire EDM are just a few of the machine tools that today's CAM systems can support. A user may quickly construct tool paths with simpler geometry, enhanced tool axis tilt for higher feed rates, better tool life and surface polish, and the best potential cutting depth using today's CAM software. Modern CAM software frequently handles tasks other than cutting, such as machine tool probing (Rao & Cheetham, 2001).

Production is coordinated with the rest of the company's activities from the design phase through post-production servicing in the field when PLM and the extended enterprise LMS are utilized.

Modern CAM solutions can be updated from a standalone CAM system to a fully integrated multi-CAD 3D solution-set to ensure user-friendliness. These comprehensive systems cover parts planning, shop documentation, resource management, and data management and exchange. These solutions must be protected against tool-specific data, which can only be accomplished with a dedicated tool management system.

Machining Technique

Most machining methods are divided into phases, each of which can be completed using a range of basic and advanced techniques depending on the design of the item, the material used, and the software available.

Roughing

Begin with a raw billet or roughcasting and have a CNC machine roughly mold it to the shape of the final model, omitting the finer details. Milling, in most circumstances, produces the appearance of terraces or stairs because the technique "steps" down the portion many times as it eliminates material. As a result, when used to create horizontal cuts, the machine's capabilities are substantially enhanced. Trochoidal milling, plunge roughing, offset roughing, and zigzag clearing (adaptive clearing) are all common approaches (adaptive clearing). Now is not the time to be concerned with exact measurements; instead, concentrate on cutting as much material as possible as rapidly as possible (Porada et al., 2013). After roughing a part, a tiny amount of surplus material is left behind to aid in the finishing process. (s)

Semi-finishing

A roughed portion that is a close approximation of the model is generated and then cut to a given offset distance from the model. To be successful with the semi-finishing pass, a little amount of material (the scallop) must remain for the tool to cut precisely without undue deflection of the tool and material away from the cutting surfaces. Raster passes, waterline passes, continuous step-over passes, and pencil milling is all regularly utilized approaches.

Finishing

The final output requires multiple, precisely timed light strokes across the material. Finishing techniques frequently entail fewer passes to limit the potential of tool deflection and material spring back. While feed rates and spindle speeds are frequently increased to maintain the correct surface speed (SFM), tool engagement is typically reduced to avoid lateral tool stress (SFM). High-speed machining (HSM) has the potential to manufacture high-quality goods fast by utilizing a light chip load, a high feed rate, and high revolutions per minute (RPM). The outcome of these milder passes is a precision component with a clean, uniform finish. Machine operators typically employ finishing end mills that are never used for roughing, as well as a variety of speed and feed adjustments. This prevents streaks and other difficulties caused by chips on the cutting surface of the end mill (Pahlavan & Makela, 2002).

Detailed Milling

Contouring in milling applications using rotary table and/or rotary head axes is used to produce specialized finishing. Rather than approximating a surface in fine-grain increments, the workpiece or tool is turned so that the tool's cutting surfaces are tangent to the ideal component features. As a result, the surface quality is higher, with tight tolerances. Turbine and impeller blades are two examples of biological structures that require this technology for production due to their intricate curves and overlapping geometries, which make ordinary three-axis machines difficult to build.

Figure 14.11: Smart industry concept.

Source: https://media.istockphoto.com/photos/smart-industry-control-concept-picture-id1171902434?k=20&m=1171902434&s=612x612&w=0&h=wVy0UIUbGvnWNLrngSwCfEFxHQh6JoxH42g3L802sfs=

14.7 FLEXIBLE MANUFACTURING SYSTEM (FMS)

A flexible manufacturing system (FMS) is a sort of assembly line arrangement that can easily adjust to changes in the style and quantity of the product. Machines and automated systems have the capability of producing a wide variety of components and can even react to varying production levels.

Because of the increased efficiency of a flexible manufacturing system (FMS), a company's production expenses can be decreased. A make-to-order strategy also strongly relies on flexible manufacturing because it allows clients to have their products created just for them (Otsuka & Kakeshita, 2002).

Higher starting expenses, on the other hand, are sometimes connected with higher adaptability. In comparison to more traditional systems, the cost of acquiring and implementing the specialist technology required for such adaptability may be significant.

Figure 14.12: Stainless steel flexible.

Source:https://media.istockphoto.com/photos/various-kind-of-stainless-steel-flexible-hose-and-flange-for-high-and-picture-id1386710380?k=20&m=1386710380&s=612x612&w=0&h=mpECMbUdqIZgDjvN2oTDjr5YWWKPB_dI-Oni4i0eE5Uc=

14.8 ADAPTIVE PRODUCTION SYSTEM FUNCTIONAL PRINCIPLES

In a flexible manufacturing system, networked processing workstations and computer terminals can handle anything from loading and unloading to machining and assembly to storing, quality testing, and data processing. The system can be configured to manufacture one set of items in a predefined quantity, followed by another set of products in a different quantity (Nisbet et al., 2002).

A make-to-order production process that allows for customer customization is another example of flexible manufacturing.

CHAPTER 15

INFORMATION SYSTEMS AND TECHNOLOGY

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INTRODUCTION

The topic of information systems offers many developing professional options for anyone interested in a career in technology. In the end, what's the difference between systems and technologies in terms of information? Even though these two terms are commonly used interchangeably, they allude to two unique career paths that necessitate completely different skill sets and educational backgrounds (Moore, 2013). Information technology and information systems are two separate areas that give various training and growth chances.

Figure 15.1: Cloud Computing.

Source: https://media.istockphoto.com/photos/cloud-computing-concept-communication-network-picture-id1277731016?k=20&m=1277731016&s=612x612&w=0&h=xwj4AeLiu3C5HS-IcMV-tr0NXpqJwotlk8-8z-ROV1M=

15.1 WHAT EXACTLY IS THE FIELD OF INFORMATION TECHNOLOGY?

The study, design, implementation, maintenance, and administration of computer-based information systems is known as information technology. Maintaining a system's hardware, software, databases and networks is its key objective, and providing counsel to users on how to get the most out of its capabilities is its ultimate goal (MacIá, 2005). In addition to educating students on how to think critically and creatively about how to apply technology to solve business problems, an online IT degree covers a wide range of topics, including computer software, cyber and data security, and project management, among others.

15.1.1 What Do Information Systems Consist Of?

The word "information systems" refers to the organization and management of a wide range of data, including not just the technology and software but also the people and processes involved. As part of an information systems degree, students learn about both programming and communications, allowing them to learn about both the technical planning and business management elements of the sector.

15.1.2 Is Information Technology A Subset Of Information Systems?

Both information technology and information systems rely on computer-based systems, but they demand various degrees of education and expertise. An information system's technological component is referred to as information technology. Rather than serving as a barrier between people and technology, information systems serve as a connecting relationship between the two (Martin, 2010). Despite their similarities, the two vocations require completely different sets of talents and offer quite different career prospects.

15.2 BIOMETRICS

15.2.1 The Notion of Biometrics.

An individual's physical and behavioral traits can be assessed statistically using biometrics. Uses for the technology include access control, identification and tracking of individuals. Biometric authentication is based on the notion that each individual may be independently identified based on their unique collection of physical or behavioral traits(Adamovich et al., 2017). We use the term "biometrics" because the Greek terms bio and metric are combined to produce the phrase.

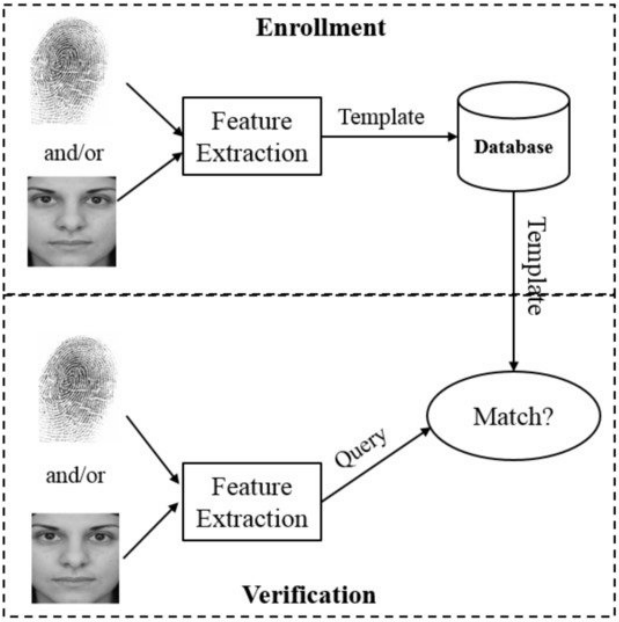

Figure 15.2: An example of biometrics.

Source: Yang W, Wang S, Sahri NM, Karie NM, Ahmed M, Valli C. Biometrics for Internet-of-Things Security: A Review. Sensors. 2021; 21(18):6163. https://doi.org/10.3390/s21186163

15.2.2 What Are Biometrics?

Personal electronic gadgets, POS software, and corporate and government security systems all use biometric authentication in some form. Using biometric verification has been inspired by both ease and security because there are no passwords to memorize or security tokens to carry Gait analysis, for example, is a biometric approach that can be applied without the individual being validated.

Scanners or readers take biometric data, the software puts it into standard digital format and compares match points with previously saved data, and the database stores all of this information securely for comparing reasons (Liu & Zhang, 2011).

As a result, even though most modern biometric systems use a local technique to collect biometric data and cryptographically hash it, biometric data can be retained in a centralized database for use in authentication and identification.

15.2.3 Biometrics of Several Sorts

Biometric identification relies on both physiological and behavioral factors.

Physiologic identifiers include facial recognition, fingerprints, finger geometry, iris and vein recognition, retina scanning, voice recognition, DNA matching, and digital signatures.

The Cloud as a Tool The term “cloud computing” refers to the delivery of computer services, such as servers, storage, networking, and intelligence, via the Internet or a “cloud” Remote data storage and processing are now possible thanks to cloud computing (Lieber, 2003).

Having a data center in a different place that is fully operational and accessible through the internet is possible.

To automate repetitive procedures and manage data, security features, storage space and processing power required to transmit data between user devices and the cloud, providers deploy management software.

15.3 CLOUD COMPUTING IN A VARIETY OF FORMS

In general, there are three categories of cloud computing services:

To date, SaaS is the most often utilized cloud-based service, making it possible for clients to access programs through a web browser or mobile app without the need for any additional hardware or software maintenance on the customer’s part The subscription prices for many services are either monthly or yearly, but some are free.

IaaS suppliers outperform SaaS providers because they provide all of the necessary hardware, software, servers, and storage to their customers. Only the services that are used are paid for by IaaS consumers, unlike SaaS users. Hourly pricing is given from some vendors. Even though IaaS isn’t always the most cost-effective choice, it permits constant, quick expansion in both directions (Liu & Ihl Woo, 2006).

Apps can be generated and deployed on the platform as a service. It is achievable to buy all a corporation requires from a single source, from construction to testing to distributing and updating to new features.

15.3.1 Characteristics of the Cloud

Cloud computing comprises five fundamental characteristics: Internet access, customer service metrics, resource pooling, on-demand self-service, and quick elasticity are all readily available.

Every single function, from generating a report to sending an email, should be done by consumers without the need for assistance from an IT specialist or data analyst.

The study of computers is known as computer science. As an area of natural science that employs computers to apply mathematical models to describe and resolve physical processes, computational science gives solutions to scientific issues.

Any natural system can be represented mathematically, as previously shown. Computers make it easier to evaluate, process, and duplicate these operations, compared to human capabilities alone. Computing science is conceivable because of the ever-increasing and ever-improving computer capabilities.

Computation is a rather new development from the other two well-established scientific disciplines. Any behavior, process, or system may be characterized and studied using theory, experimentation, and computing (Kobayashi et al., 2019).

To acquire a complete grasp of any system, they must perform together. Computational science can be applied when experimental procedures are no longer practicable or applicable.

It is widely thought that computational science comprises three disciplines: science, computer science, and mathematics. In this usage, the term "science" refers to both theoretical and experimental components, frequently a particular scientific discipline.

15.4 SCIENCE BASED ON THE APPLICATION OF COMPUTATION

Computer science may be used for the study of any natural process, system, or event that can be conceived of. It establishes connections among several different scientific fields to provide answers to problems in the scientific community.

Similarly, theoretical chemistry, computer science, and applied mathematics are all components of computational chemistry.

The following section is a sampling of the several areas that have emerged as a result of the applications of computational science.

15.5 COMBINING BIOLOGY WITH INFORMATION TECHNOLOGY

Computational biology refers to the study of biological systems, such as anatomical, ecological, evolutionary, behavioral, and social systems. Behavioral and social systems are also included (Howe-Walsh & Turnbull, 2016).

The following list explains the several subfields that fall under the umbrella of computational biology.

15.5.1 Statistics Regarding Family Trees

The sequencing of genes has included computational approaches, and a portion of our current understanding of genomes may be attributed to the study conducted using computers. Using computational genomics, it is possible to carry out a variety of applications, including comparative genomics, gene expression assessments, study on gene evolution, mining of biosynthetic gene clusters, and others.

15.5.2 Computational Medicine and Biology Medical

The field of computational biology has a wide variety of potential applications in medicine due to its ability to predict how human systems would behave. For example, computational oncology and pattern analysis of tumor origin and progression can lead to a better understanding of the situation.. It may be possible to predict the effect that medications will have on cancer cells by making use of computational approaches, for example. The field of computational immunology, which contributes to the study of the immune system, can be of assistance in determining the factors that lead to and result from infectious diseases (Zhang et al., 2018).

15.6 BIO MODELING WITH THE ASSISTANCE OF COMPUTERS

From the molecular level up to the organismal level, computational biology allows for the representation of every facet of biological systems, including the human body. Everything, from the activity in the brain to the architecture of molecules, may be recreated and utilized for various scientific purposes. In the past several years, there has been a significant advancement in bimolecular modeling, and improvements in technology have made it much easier to investigate the chemistry and structure of biomolecules.

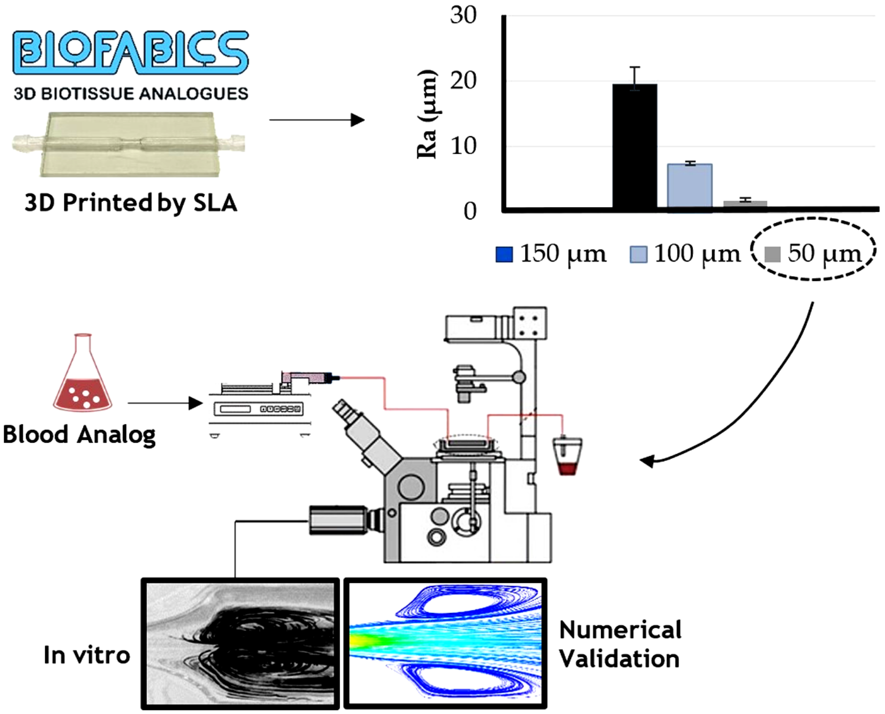

Figure 15.3: Biomodeling.

Source: Carvalho V, Rodrigues N, Ribeiro R, Costa PF, Lima RA, F.C.F. Teixeira S. 3D Printed Biomodels for Flow Visualization in Stenotic Vessels: An Experimental and Numerical Study. Micromachines. 2020; 11(6):549. https://doi.org/10.3390/mi11060549

In addition to this, we may develop ecological models that provide information on the interactions that occur in ecosystems. It is possible for humans to better appreciate changes in the environment if we have a better understanding of the behavioral characteristics of plants and animals. If, for instance, one investigates how changes in the migration patterns of birds, one might be able to explain how global warming is affecting these creatures and how it is progressing (Zeldin et al., 2008).

15.7 THE CALCULATIVE SCIENCE OF CHEMISTRY

Computational chemistry is the branch of chemistry that makes use of computers to investigate, forecast, and gain an understanding of chemical processes, molecular structures, and characteristics. Computational chemistry is an interdisciplinary field that combines quantum physics and chemistry. The Schrodinger equation is the foundation for the vast majority of the computational methods used in computational chemistry.

Methods:

Molecular mechanics, density functional theory, ab initio techniques, and empirical methodologies are all utilized in the field of computational chemistry. These several methods can be applied in a wide variety of situations.

Molecular modeling

Computer modeling is carried out so that x-ray diffraction data may be evaluated and molecular structures can be comprehended more effectively. Because of this, the accuracy of the predictions and interpretations that may be made regarding molecule structure is improved (Wu et al., 2019). It is also possible to use computational chemistry to find connections between the structures of molecules and the properties of their physical environments.

The Reactions Involved In Chemistry

The pharmaceutical industry is one of the most important and well-known fields that has utilized computational chemistry to anticipate chemical interactions. This is because the pharmaceutical industry deals with complex molecules. The use of computer modeling can be beneficial in the process of developing new medications. It is possible to employ simulations to foresee the results that might follow from changing the molecular structure of a drug. This expedites and boosts the process of disease modeling and the design of pharmaceuticals.

The study and analysis of physical problems using computational and modeling techniques are what is meant by the term “computational physics.” Computational models are used in virtually all subfields of physics, and the science of physics has a diverse variety of practical applications. They appear in more than one of those (Antal & Grønli, 2003).

15.8 SIMULATION OF THE MECHANICS OF FLUIDS AND OTHER USES

The study of fluid flow using computer models is what computational fluid dynamics, or CFD, is all about. Although CFD makes use of a variety of approaches, the fundamental technique is always the same. The building of a CAD model comes after the construction of a mesh and the configuration of the system's boundary conditions. After that, the problem with the simulation is handled by employing iteration.

Utilizing computers for astronomy

Both theoretical and experimental approaches are deficient when it comes to researching or predicting large-scale astronomical events with any degree of accuracy. It is not possible to use experimental methods to analyze a supernova. Computer physics contributes to our understanding of the birth and lifetime of stars by allowing us to solve computational models of supernovae (Woolgar & Lezaun, 2013).

Nature

The unique insights that computational imaging has provided on black holes were recently studied in a study paper that was published in the field of Computational Science.

Electromagnetism Calculation

This research investigates, via the use of computer models, how electromagnetic forces interact with the physical components of their surroundings.

Computational Finance

The field of computational finance has been more well-known in recent times and is now being utilized in a variety of subfields within the financial industry. In most cases, the best investments are made with the assistance of professionals who are trained in computational finance (Wang, 2009).

Optimization

The use of computational science is most effective when used to optimize problems that need several rounds of trial-and-error testing. Computing allows for the quick and accurate completion of a variety of tasks, including risk analysis, portfolio optimization, and asset pricing.

Precision is essential in the trading industry since decisions need to take into account time, price, and volume. Algorithmic trading is the method that may be utilized to automate this procedure. It does so by making use of computational models and predictive evaluations (Wynne, 2007). High-frequency trading is an additional way to algorithmic trading that is based on algorithms.

15.9 COMPUTATIONAL SOCIAL SCIENCE

The field of computational social science focuses on researching solutions to social problems, including, but not limited to, the behavioral patterns of human societies, cultural evolution, interpersonal interactions, and economics.

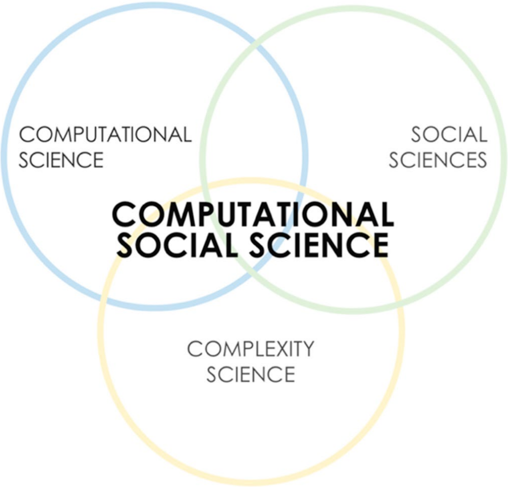

Figure 15.4: Computational social science.

Source: Lettieri N. Computational Social Science, the Evolution of Policy Design and Rule Making in Smart Societies. Future Internet. 2016; 8(2):19. https://doi.org/10.3390/fi8020019

15.10 THE CONTRIBUTION OF TECHNOLOGY TO SOCIOLOGY

The field of computational science enables the simulation of social interactions on both a local and a global scale. It is possible, with the use of computer models, to devise predictions about human civilization's behavior that are grounded in realism. The development of this field is now being aided by developments in "big data," "data mining," and "social data analysis." The Internet and other social media platforms generate a vast amount of data that may be collected, categorized, and put to use in the development of simulations of human behavior to conduct a study on behavior. Additionally, computer science and social modeling both have applications in the field of marketing (Woellert et al., 2011).

Economic Calculation

In contrast to computational finance, this area of finance focuses on the process of predicting the behavior of economic models. The use of computer analysis makes it possible to forecast the growth and direction of the economy to some extent.

The Scientific Study of Computation and the COVID-19 Outbreak

The ongoing effort to combat the COVID-19 epidemic has benefited from computational science in a variety of different ways. The use of computer models has improved a variety of processes, including decision-making, mapping illnesses, predicting how the general population will react, researching vaccines and drugs, and understanding how viruses operate. In addition, the recognition of bimolecular modeling as a useful instrument has resulted in a significant increase in the application of this technology as well as its spread around the world (Whitcombe et al., 2014). It is anticipated that this will continue to have an effect even after the epidemic has passed.

15.11 CONFORMANCE TESTING CAN BE DONE IN A VARIETY OF WAYS

The following logical and physical modes of testing are included in conformity testing: compliance, load, stress, and volume testing.

Why is it required to perform conformance tests?

Assess the system's criteria and documentation to make sure they're all being met.

Design, development, and evaluation must all meet the established standards.

What kinds of examinations are necessary?

The scope of the requirements, the objectives of the specifications, and the implementation standards.

Because they are confident in their mastery of the standards, specifications, and procedures, the management team begins the compliance testing(Verbeek et al., 2002).

Standards and requirements must be conveyed to avoid misunderstandings and ensure a successful application. Your product's credibility and relevance can be maintained by doing conformity testing.

15.12 WHAT ARE THE BEST METHODS AND TIMES TO CONDUCT CONFORMANCE TESTING?

In addition to the several approaches that correspond to each phase of our Development Lifecycle, there are many others. Analyzing criteria outlined in specifications Creating a test strategy and outlining the purpose of test cases • Create test design specs documentation for completed tests. It's important to keep in mind a few more criteria characteristics, such as subsets, which commonly come in three varieties: "Profile," "Level," and "Modules," and are used to evaluate the system's general consistency, completeness, and accuracy regarding the requirements.

For each level, there are several subsets of requirements, with the most basic being Level1 and the most advanced being Level2. An individual user's profile is a subset of specifications that includes system capabilities to meet needs and is dedicated to the user's specific group.

15.13 METHODOLOGY FOR CONDUCTING TESTING TO ENSURE COMPLIANCE

Testing a software program's efficacy, performance, and safety against potential dangers requires conformance testing or compliance testing. An efficient conformance testing technique includes the steps listed below:

- Examining Requirements and Requirements for Admission
- Finding a lab to do tests in
- Setting up a set of test procedures
- Confirming that the validations are correct
- Adopting new standards for certification and testing
- Conformity testing's advantages
- Ensures that the requirements are properly executed.
- Compatibility and portability are guaranteed
- The conditions are suitably applied
- It is possible to verify the proper operation of interfaces and capabilities by performing tests on them.

Allows for the differentiation between portions that must and do not comply, such as syntax and semantics (Terrones, 2003).

Consequences of conformance testing include the following:

- Like other types of testing, conformity testing can be difficult at times. A few examples are as follows:
- It is required to determine both the system class to be tested and the suitable approach to conduct effective conformance testing.
- Profile, Level, and Module classification of needs
- Defining your priorities
- Enhancing the testing process by developing add-ons, substitutes, and tactics.
- With the help of critical thinking, conformity checks are carried out.
- Conformity testing has several aspects that necessitate further knowledge and care.
- Most appropriate methodologies of evaluation
- Automating the testing process using a testing instrument
- In-depth expertise in the non-compliance aspects of conformity testing

Establishing and executing a compliance testing program making sure that you've chosen the right amount of formality

15.14 RULES AND REGULATIONS

Mobile System Conformity Testing:

Mobile system conformance testing is possible, much like other types of software testing. Before deployment, a conformance test is performed after system construction to verify that the system is operationally ready (Sismondo, 2018).

GSM and CDMA networks require different types of testing, such as compliance and interoperability.

Protocol testing, safety/security testing, SIM card testing, radio frequency testing, and audio testing are some of the types of tests that are included in this checklist.

Using computer-based algorithms, a cyber-physical system manages or monitors an apparatus. Physical and software components in cyber-physical systems are strongly intertwined, allowing them to operate in many spatial and temporal dimensions, display a range of distinct behavioral modalities, and interact in context-dependent ways. Mechanical and cybernetic concepts are all incorporated into CPS, as well as those from design and process science. Process control is a typical term for embedded systems. Computability is often given precedence over the interplay between physical and computational components in embedded systems. CPS and the Internet of Things have a similar underlying design, but CPS is more tightly integrated and coordinated in terms of the physical and computational worlds (Shannon et al., 2010).

The intelligent power grid, autonomous car systems, medical monitoring, industrial control systems, robotics systems, and automated pilot avionics are all examples of CPS applications. Cyber-physical systems have been pioneered by several industries, including aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer electronics.

15.15 CYBER SECURITY

Systems and sensitive data are shielded from ever-increasing threats by a combination of best practices and cutting-edge technology in the field of cyber security.

15.15.1 Describe The Dangers Of Cybercrime

Protecting sensitive data and critical systems from cyber-attacks is the goal of cyber security. A company's networked systems and applications might be harmed by cyber security measures, which are also known as information technology security.

Data breaches will cost US$3.86 million on average worldwide and US$8.64 million in the US by 2020. There is a wide range of penalties, including the price of identifying and fixing the breach, the cost of downtime and lost income, and the long-term damage to a company's reputation and brand. Personal information like names, addresses, National Insurance Numbers, and credit card numbers are traded on illegal online black markets (Adamovich et al., 2017). Customer distrust and regulatory penalties are common outcomes of compromised personal information, as are legal actions in the most serious cases.

These costs may rise due to the increased complexity of security systems brought on by new technologies and a lack of internal expertise. However, organizations can more effectively combat cyber threats and limit the lifetime and impact of breaches when they occur by establishing comprehensive cyber security policies informed by best practices and automated with sophisticated analytics, artificial intelligence, and machine learning.

15.15.2 Domains for Safety on the Internet

There are multiple levels of protection against cybercrime in a comprehensive cyber security strategy, such as preventing unauthorized access, data alteration or deletion, extortion of funds from customers or the organization, or other disruptions to normal business operations. There should be countermeasures to protect computer systems, networks and other assets that are critical to society's well-being, economic health, and national security. Additionally, the US Department of Homeland Security assists in this area through the National Institute of Standards and Technology.

The security measures put in place to keep hackers out of a computer network, including wireless and wired connections, are known as "network security."

Locally installed programs as well as cloud-based ones are both included in the definition of application security. Authentication of users, data processing, and other aspects of application security should all be considered during the development process (Suryanarayana et al., 2001).

Security in the cloud, particularly in the form of genuine confidential computing encrypts cloud data while it is in use and while it is in transit.

Regulations like the General Data Protection Regulation are designed to keep your most private information out of the hands of others who might misuse or steal it.

The company's endpoint security will be improved by raising the level of end-user security awareness. For example, users can be instructed to reject suspicious email attachments and to avoid USB devices that they have never seen before.

Disaster recovery and business continuity policies aim to keep essential operations running as normally as possible in the event of unplanned occurrences like power outages, natural disasters, or cyber-attacks.

In terms of storage security, IBM Flash System offers a comprehensive set of safeguards and rock-solid data resiliency. Encryption and separate, immutable copies of data are both parts of this(Swierstra & Rip, 2007). These backups are kept together so that they can be restored quickly in the event of a cyber-attack and its consequences.

Misunderstandings about cyber security can be dangerous. Some misconceptions persist, such as the belief that foreign hackers are responsible for the rise in global cyber security incidents. There are many instances where malicious insiders, either alone or with the help of external hackers, are responsible for cyber-attacks. There is a possibility that these insiders are part of state-sponsored and well-organized organizations (Small, & Klavans, 2014).The dangers are well-known. Many new vulnerabilities have been discovered in both new and old programs and devices, making the risk surface even larger. Human error has also increased, primarily as a result of careless employees or subcontractors who compromise client information without realizing it.

There are only a few ways to attack. New attack vectors, such as Linux systems, operational technologies, Internet of Things devices, and cloud configurations, are discovered every day by cybercriminals. Every government and private-sector organization is vulnerable to cyber-attacks because of the necessity of communication networks (Rogers & Marres, 2000). Even non-profits and municipal governments are being targeted by ransomware attacks. There are threats to critical infrastructure, supply lines, and ".Gov." domains. '.Gov.'

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Encyclopedia of Science and Technology

Recognizing that in a globally integrated, knowledge-based world, comparative advantage shifts to those who can assimilate and employ amazing developments in science and technology for development, this volume examines science and technology and its role in the modern world by reviewing its various applications. Science and technology are the keys to the progress and development of every country. Technology plays a fundamental role in the creation of wealth, improved quality of life, and real economic growth and transformation in every society. With this in mind, this volume explores the concept of technology, emphasizing the relationship between science and technology, the key role of science and technology in social development, and the significance of science and technology in national development.

The volume critically classifies and examines the role of science and technology in all areas of life including poverty alleviation, affordable energy, water supply, health, agriculture, environmental management, rural development, education and economic growth. Science, technology and innovation each represent a growing category of activities that are highly interdependent but distinct. Science contributes to technology in a number of ways: (a) research tools, laboratory techniques and analytical methods are used in research and ultimately into design or industrial practice through interdisciplinary approaches; (b) research practice as development and assimilation ultimately contributes to useful new human skills and capabilities for technology; (c) The creation of a knowledge base that is increasingly important in assessing the wider social and environmental impacts of technology;(d) new knowledge as a direct foundation of ideas for new technological prospects; (e) sources of tools and techniques to improve the efficiency of engineering design and knowledge bases for assessing design feasibility; (f) knowledge bases to enable new technology for applied research. The negative impact of technology on science is at least as important: (1) by providing a wealth of resources for new scientific problems, thereby helping to justify the allocation of resources needed to address them effectively and in a timely manner, and expanding the scientific agenda; (2) as a source of otherwise inaccessible tools and techniques to more effectively solve new and tougher scientific problems.

Particular examples of each of these dual-way interactions are discussed. Because there are many indirect and direct links between science and technology, the portfolio of studies with potential societal benefits is broader and more diverse than just looking at the direct links between science and technology would suggest. Since the advent of recorded history, the development of technology has been closely related to the convenience and prosperity of human life, while science has its origins in natural philosophy and is aided by people's curiosity. Of course, while technological progress is supported by various scientific advances, this does not mean that scientific research is done to develop new technologies, but that scientific knowledge is used only because it is available. In fact, it is more common to develop new technologies for scientific research. Nonetheless, science is no longer the business of the intellectual world, and scientific results now push the boundaries and expand the potential of human activity, both in space and time. According to the volume, science also has a great influence on people's values, changing the nature of society and becoming the engine of social progress from a civilizational point of view.

Prof. Ramesh Chandra is an outstanding scientist, revered teacher and an exceptionally successful administrator. He is currently heading Department of Chemistry, University of Delhi, where he is serving as Professor for the last more than 26 years and Founder Director of Dr. B. R. Ambedkar Center for Biomedical Research, University of Delhi, since March 1991. He has been Vice-Chancellor, Bundelkhand University, Jhansi for six years (1999-2005); Member, Planning Commission, Government of U.P, India as well as the President of the Indian Chemical Society (2004-2006). Professor Chandra started his research career at the University of Delhi, thereafter he went to The New York Hospital-Cornell University Medical Center and the Rockefeller University, New York; State University of New York at Stonybrook, USA as Assistant Research Professor. He conducted advanced research at the Harvard University Medical School- Massachusetts General Hospital, jointly at MIT, Cambridge, USA. Over the last 38 years, Professor Chandra has contributed largely in the field of Chemical Sciences and particularly in New Drug Discovery and Development as well as Drug Metabolism. He has to his credit several patents, published more than 300 original Scientific Research Papers/ Review Articles in International journals of repute and six of his internationally acclaimed scientific Books. Prof. Chandra is the recipient of several professional national/ international recognitions; these includes: Millennium Plaques of Honor (Life Time Achievement Award for Contribution in Science & Technology) by the Indian Science Congress Association (ISCA) for 2017-2018, Award of the Highest Honor of Soka University, Tokyo, Japan (2000); J William Fulbright Scholarship (1993); The Rockefeller Foundation USA-Biotechnology Career Award (1993); and several others.

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